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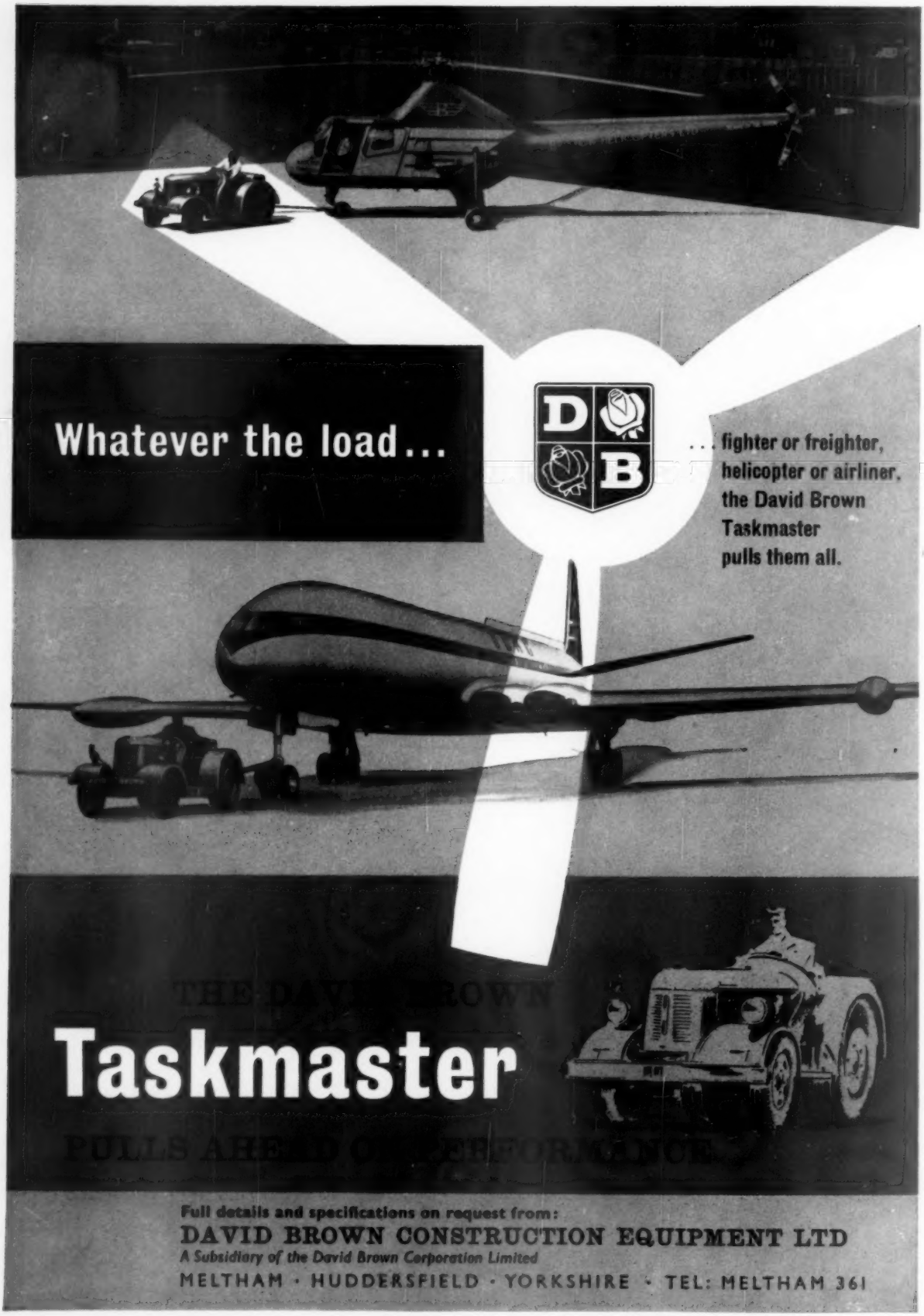
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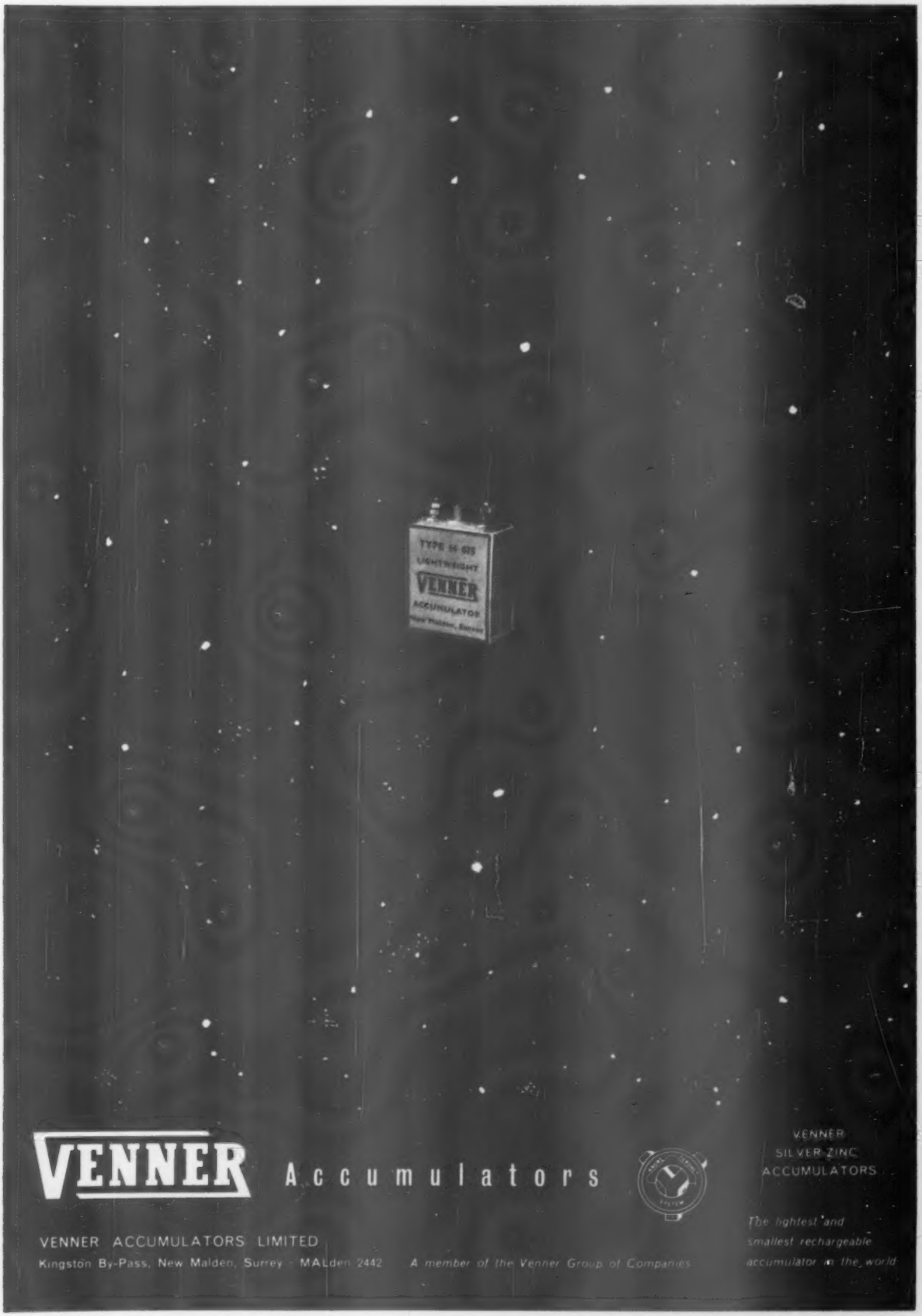
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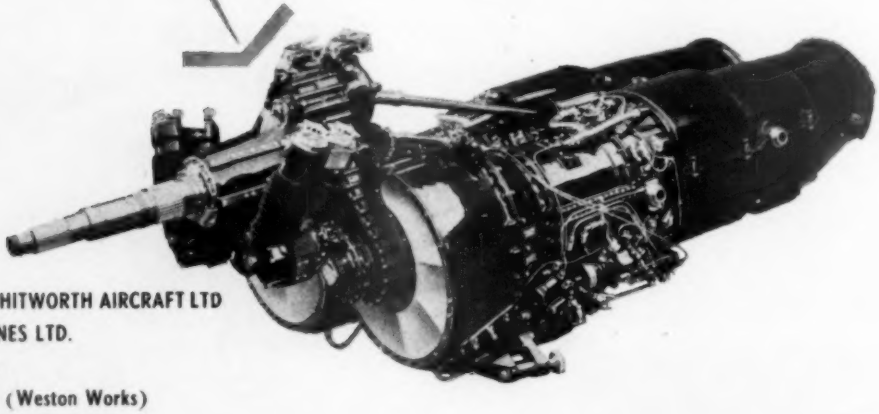

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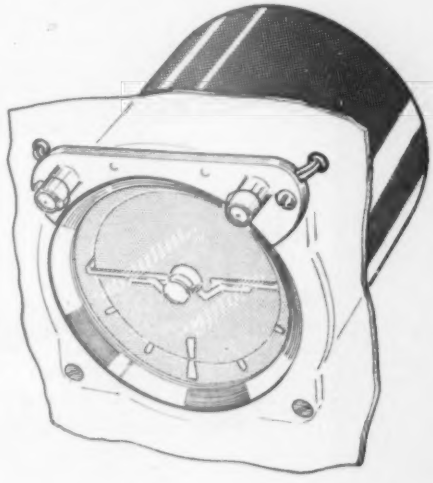

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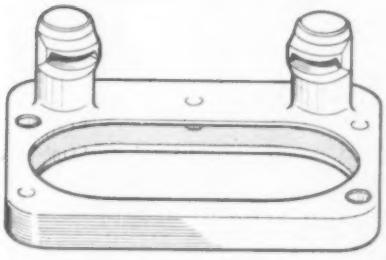

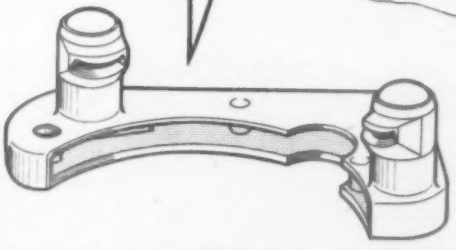

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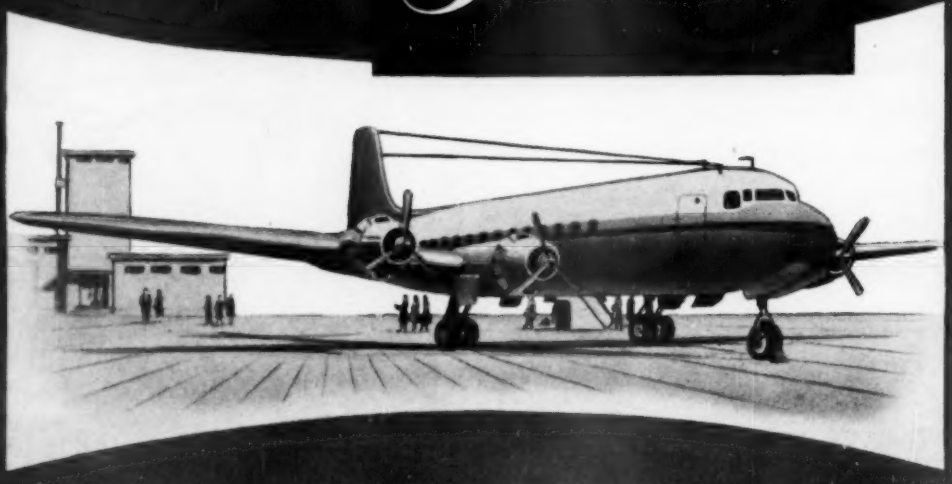

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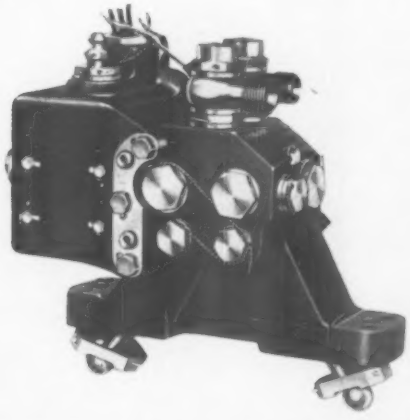

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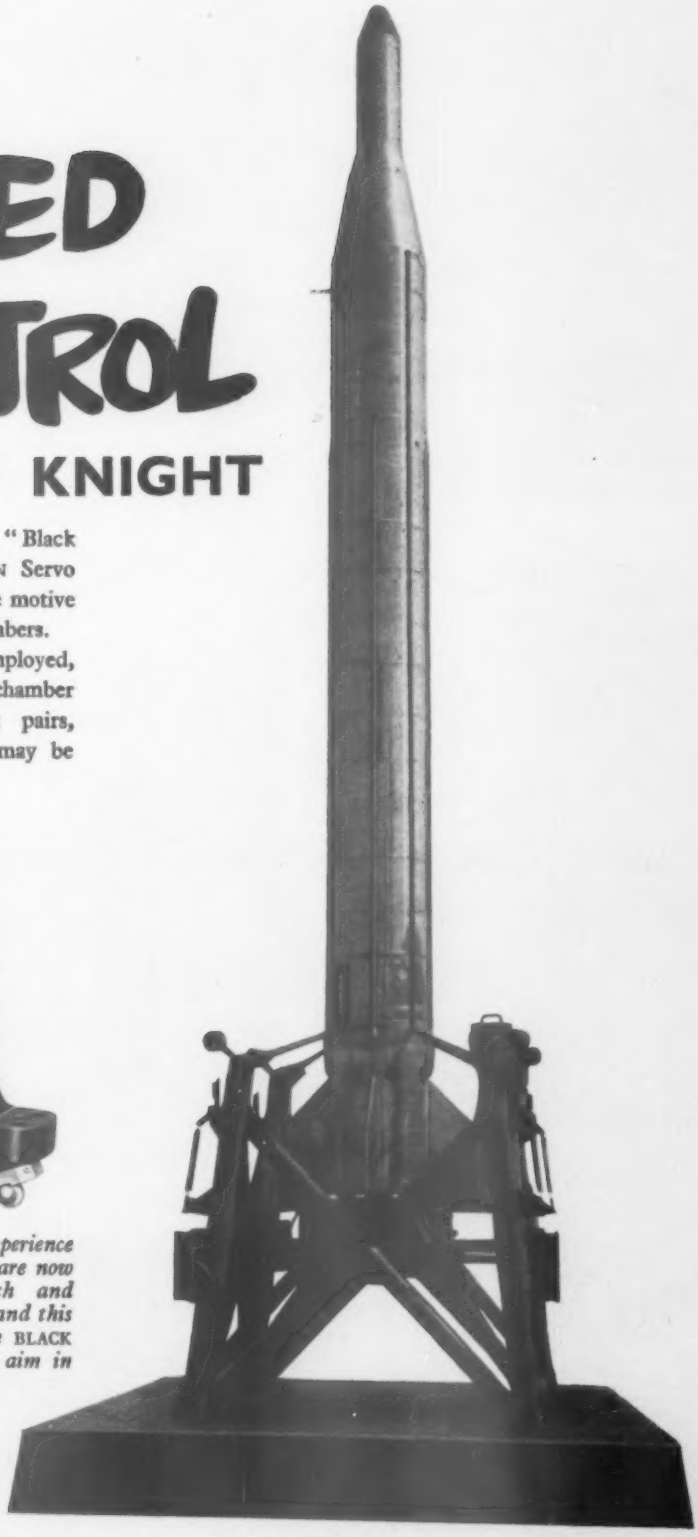

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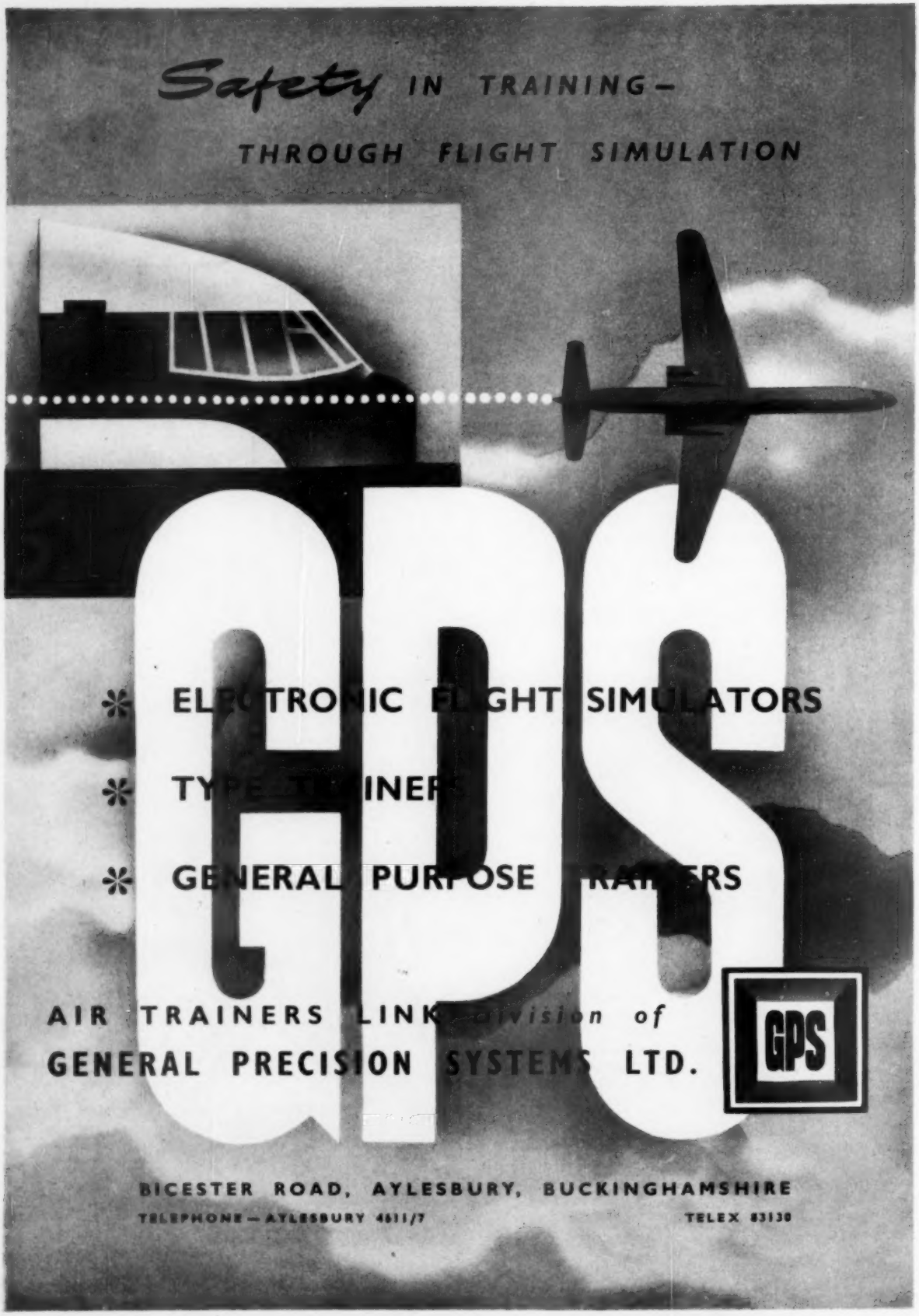
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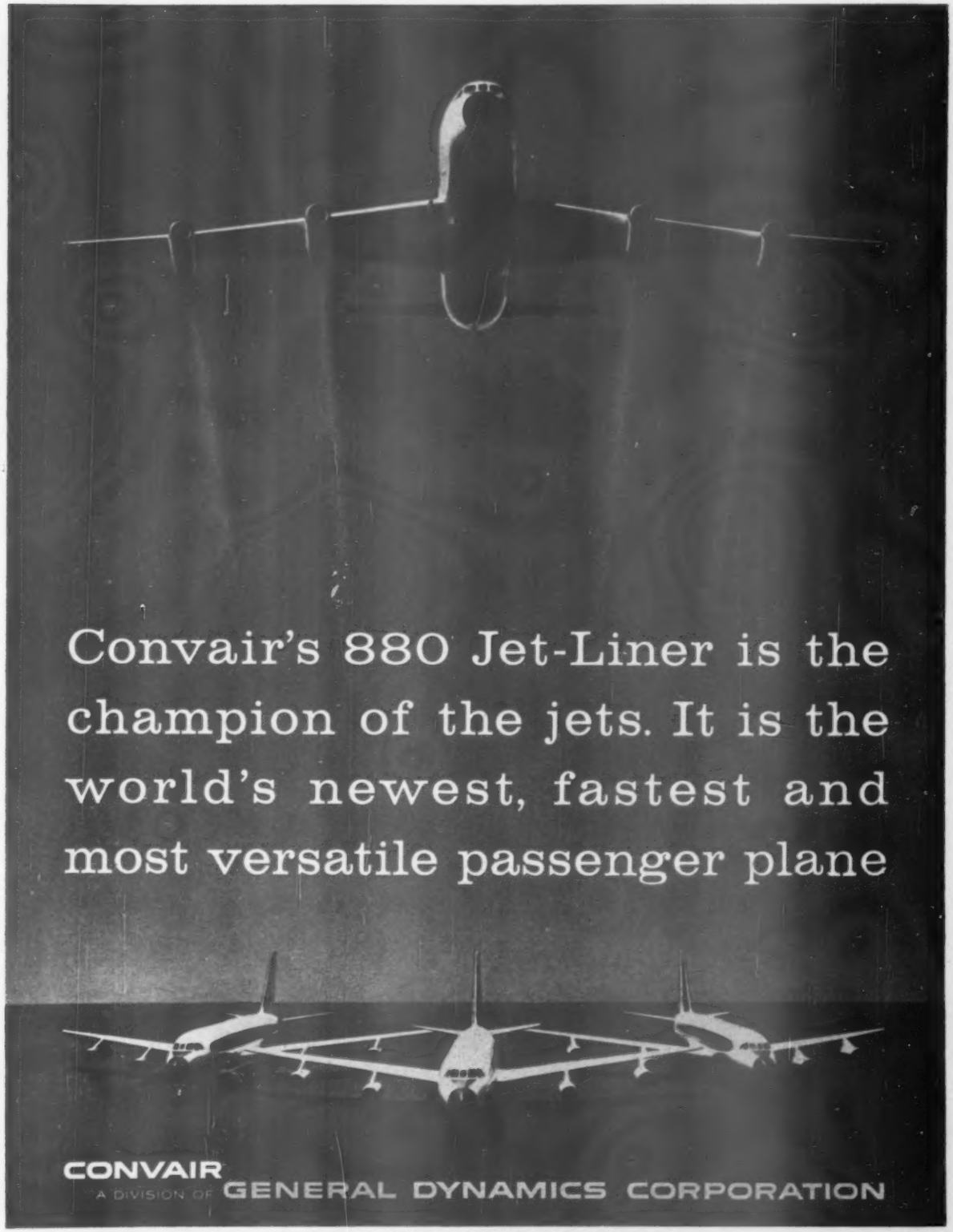
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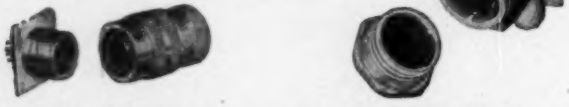

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One of the most famous comets is Halley's, which reappears every seventy-five years. References to it, and drawings, exist from many centuries back: it was seen over Jerusalem in A.D.66, in the Autumn of 684 near the Pleiades as a circular object without a tail, and its appearance in 1066 caused great alarm—it was duly recorded in the Bayeux tapestry, 'Isty mirantur stellam'—while in 1456 its appearance is said to have discouraged the Turks in the siege of Belgrade. Halley gave his name to the comet by identifying its recurrence and correctly predicting its reappearance in 1759.

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As flow begins, operate the valve several times, then FULLY SHUT it.
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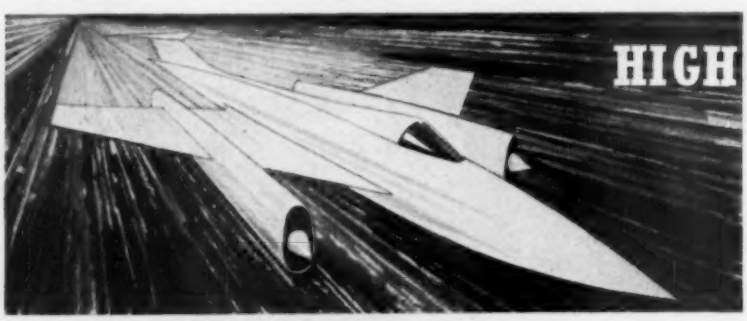

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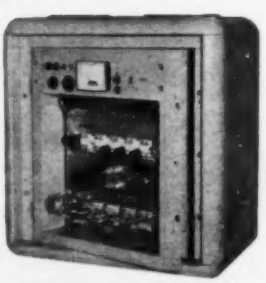

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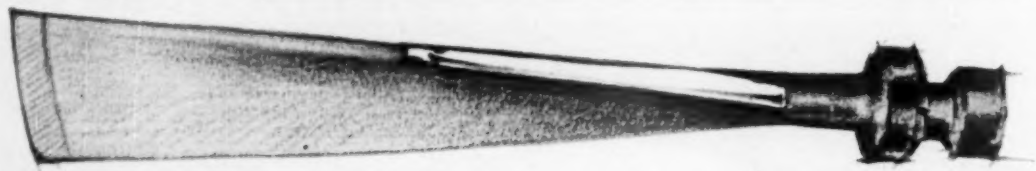

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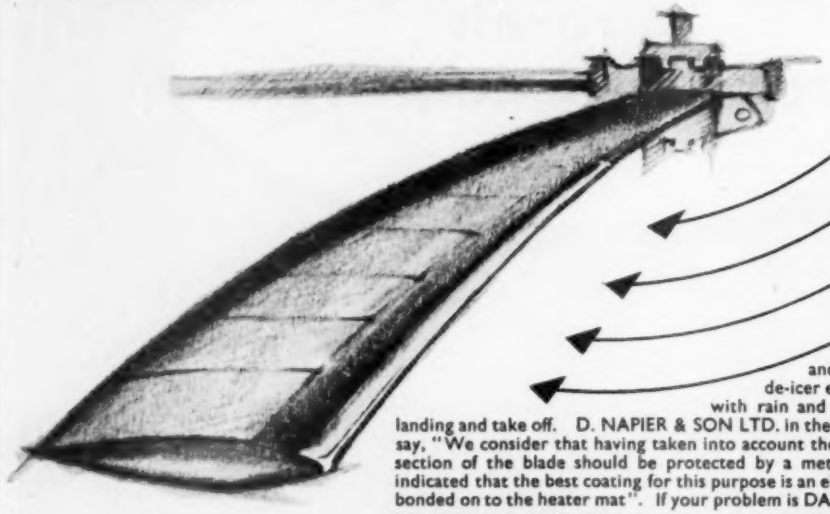

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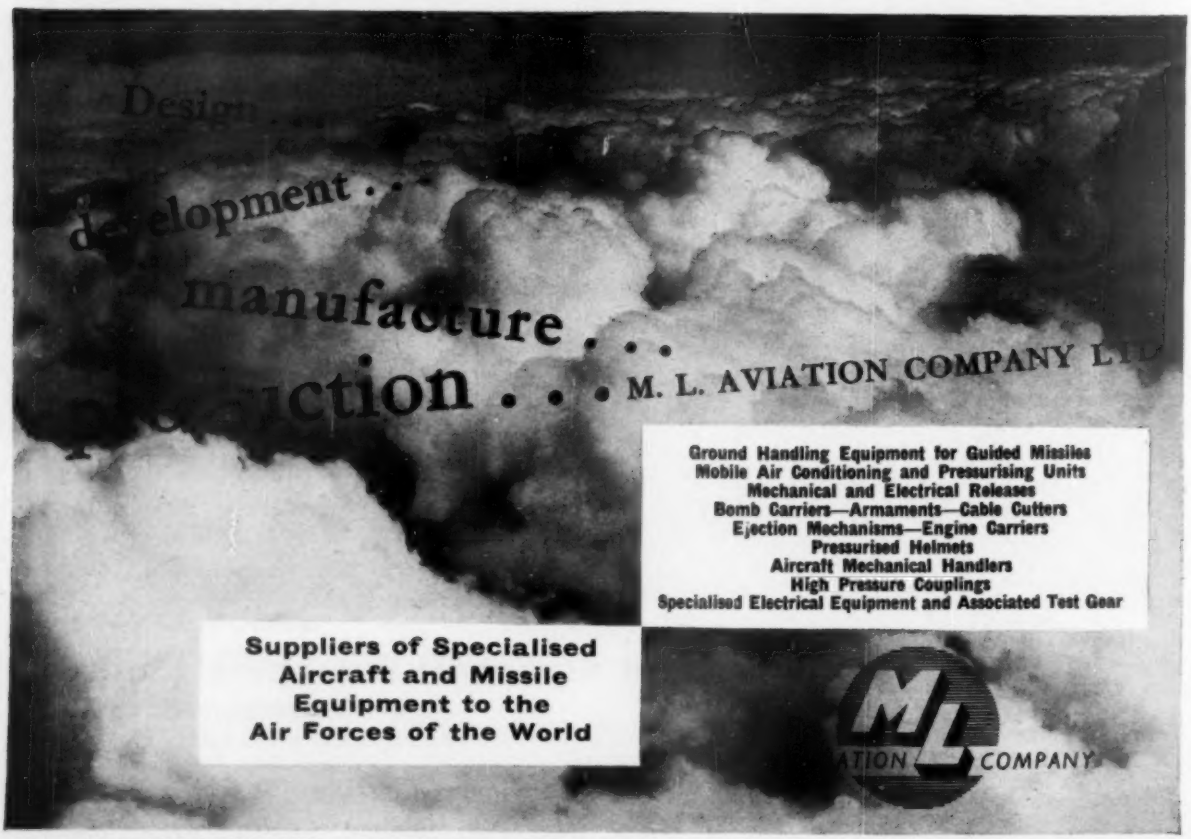
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The new JT3D turbofan has the same basic design as the JT3 (J-57) and JT4 (J-75) turbojets powering 9 out of 10 Boeing 707 and Douglas DC-8 jetliners and many military jet aircraft. Functionally, the difference is the addition of the fan and provision for a secondary flow of air. The reliability has not changed because the basic engine design has not changed. But the addition of the fan has effectively increased the thrust and decreased fuel consumption for greater operating efficiency. It is simply a case of the most reliable jet engine in its class getting even better.

By comparison with its predecessor, Pratt & Whitney Aircraft's new JT3D turbofan raises take-off thrust by 42%, boosts climb thrust by 23%, and pushes maximum cruise thrust up 13%—all this while cutting down cruise TSFC by 13%.

The JT3D, flying since July, 1959, has met or exceeded all performance guarantees and estimates and has successfully completed its 50-hour military test. Military prototype deliveries have been made. Military production deliveries start in June, commercial in July.

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THE AEROPLANE and ASTRONAUTICS

VOLUME 98 NUMBER 2527 MARCH 25, 1960

Making a Start

Exercise "Starlight," of which preliminary information was given in our last week's issue, was going strongly as we went to press. Some 3,500 men, most of them Guards, had been flown by five Britannias to El Adem. Thence they were being ferried by Beverley to Tmimi in Cyrenaica. The Brigade Group which is doing the fighting in the imaginary battle is to rely entirely for its supplies on the R.A.F. These include rationed supplies of water and boxes full of stones to simulate ammunition. An eyewitness account by a member of our editorial team will be published on his return.

Meantime, splendid though the effort is, it needs to be viewed against comparable activities in other countries. Last week on his return from a trip with the U.S.A.F., another member of our editorial team reported that an exercise now being held on the other side of the Atlantic involves collecting 22,000 troops and 12,000 tons of equipment from scattered bases, flying the lot to Puerto Rico (1,740 miles from the nearest U.S. base) and by the end of the fortnight getting everything back whence it started.

And the Military Air Transport Service of the U.S.A.F. (MATS) is worrying about the obsolescence of its ageing 485 aircraft! It needs something to replace its C-124 Globemasters.

It is encouraging to see that at long last R.A.F. Transport Command is getting modern equipment, but its spectacular performance must not lull us into complacency. What has been done is that a beginning has been made.

Supersonics—The Dilemma

No longer is there discussion in high places whether or no this country shall build a supersonic airliner; by implication a positive decision has been taken for now the debating and arguing is centred around the sort of transport which the country should set about building. Basically the question is whether it shall be designed to cruise around M=2 in which case it can be built of light alloy. If, as plenty of influential people think, it should cruise at M=3 then it will have to be built of steel or titanium.

By chance it happened that the first lecture staged by the Royal Aeronautical Society on the Supersonic Transport coincided with the anniversary of the triumphant arrival forty years ago (Mar. 20, 1920) in Cape Town of Wg. Cdr. Pierre van Ryneveld and Flt. Lt. Quintin Brand in a D.H.9 (B.H.P. Puma engine). They had set out from Brooklands on Feb. 4 of the same year in a Vickers Vimy. It took them 45 days and three aeroplanes to do the job. The Mach 2 (or thereabouts) airliner of 300,000 lb. all-up weight which seems to be the popular choice of the moment, should do the journey from London to New York in three hours.

Feasibility studies have been put in by both the new aircraft groups. It is widely accepted that the one put in by the British Aircraft Corporation is for a craft to cruise around M=2. In contrast the study prepared by the Hawker Siddeley team favours a rather higher speed and is believed to recommend the adoption of steel for the structure.

Unfortunately, the discussion following the lecture was brief. To be deplored was the fact that no airline representative took part. This is the more to be regretted as it seemed to be generally assumed that the only route worth worrying about was that between London and

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New York. One would have thought that the coming of the supersonic airliner would have made considerable changes to existing networks. It is a truism that as journey times shorten so do frequencies go up.

We have never had any doubt about the importance to British aviation of the supersonic airliner and are as anxious as anyone to see work started. Have we not been arguing the case for building one for a long time? But U.K. efforts must be viewed against the background of World activity and it would be a disaster if an effort to play safe produced an aeroplane incapable of development. It always seems to be assumed that there is plenty of time. In fact, with one or two notable exceptions our efforts in civil aircraft prove to have been left too late. We must not forget that the Government having cancelled the supersonic bomber for the R.A.F. we have lost years of useful experience whereas the U.S.A.F. have been operating a supersonic bomber for quite a while. We shall be much surprised if a Russian supersonic airliner does not appear shortly.

In such circumstances whatever sort of supersonic transport the Authorities decide to order let there be plenty of development in it. It must not be obsolescent on its first appearance.

Matters of Moment

More About the Olympus 21

A DRY thrust of 20,000 lb. is the main feature of the Bristol Siddeley Olympus BOl. 21 whose existence was announced last week (THE AEROPLANE AND ASTRONAUTICS, Mar. 18).

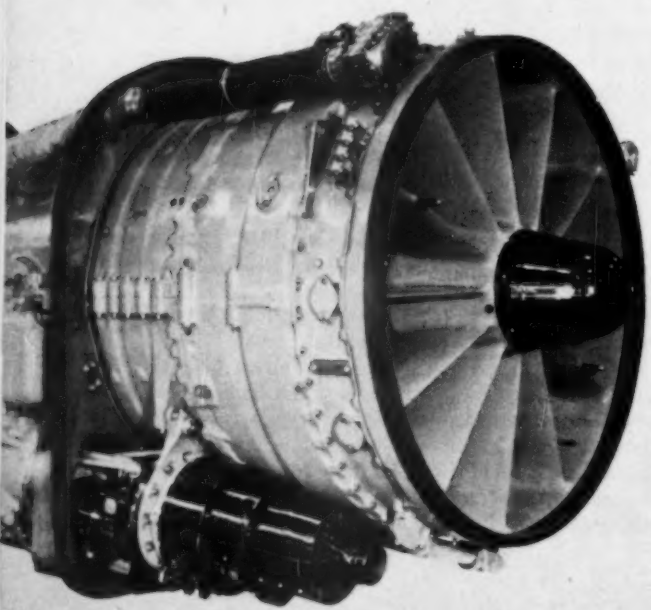
Developed from the Olympus BOl. 7 Mk. 201, the new Olympus 21 will probably also power the Avro Vulcan 2 bomber. It represents a further step towards the potent version of the Olympus which will power the supersonic TSR-2 aircraft now under development for the R.A.F.

Differences between the Olympus 21 and the earlier Mk. 201 include the addition of a zero stage at the front of its L.P. compressor and the installation of a shorter, but larger-diameter, air-intake casing. Despite the additional compressor stage, the length of the engine has been increased by only 4½ in.

There would apparently be little difficulty in installing this engine in place of the Olympus Mk. 201 in the Vulcan 2 and, according to Bristol Siddeley, it has been developed "with a view to utilizing to the fullest extent the ultimate design potentialities of the Avro Vulcan." Indeed, the relatively minor changes between the 201 and the 21 suggest that modification kits might allow the earlier powerplants to be brought up to the later standard so that in due course all Vulcan 2s could have Olympus 21 engines.

The latest Olympus would provide an additional 12,000 lb. in the total take-off thrust for each Vulcan 2 and there would also be a gain in cruising thrust. The resulting improvement in the aircraft's take-off performance might allow it to dispense with assisted take-off rocket engines.

The Olympus 21 must bring this type of engine closer to the version which will power the TSR-2. The 100-Series Olympus was extended from the Mk. 101 via zero-staging to the Mk. 102 and then by operation at higher temperatures to the Mk. 104. The 200-Series Olympus has developed from the Mk. 201 by zero-staging to the new Olympus 21. With development including advanced materials and higher-temperature operation, the Olympus 21 could, presumably, in its turn lead to a supersonic engine which, with fully variable reheat, might well meet the powerplant requirements of TSR-2. And this development in its turn suggests that Bristol Siddeley are also well placed to provide an Olympus for a supersonic airliner.



LATEST OLYMPUS.—Features of the new Olympus 21 are an additional L.P. compressor stage and a larger intake.

ARGOSY ORDER.—Mr. H. M. Woodhams, chairman and managing director of A.W.A. (left), presents a model of the Argosy to Capt. R. G. Gibson, general manager of Trans Arabia Airlines which has two Argosies on order.

Electronics and Aviation

MISGIVINGS on the part of the electronics industry that it might be faced with subsidized competition from the aircraft industry were expressed last week by the chairman of the Electronic Engineering Association, Mr. L. T. Hinton, B.Sc.(Eng.), A.C.G.I., M.I.E.E., M.I.Ex. He was speaking at the Association's 13th annual luncheon at which the principal guest was the Minister of Aviation, Mr. Duncan Sandys.

In his reply, Mr. Sandys offered a measure of comfort to his hosts. "The Government's policy," he said, "is to maintain in this country efficient capacity for the design, development and production of aeronautical equipment. It is not our intention to encourage airframe manufacturers to undertake work formerly done by specialist equipment manufacturers. But equally it is no part of our policy to try to prevent them from widening their range of business, provided they do so at their own risk and expense.

"The Government have invested large sums of public money in laboratories and other technical facilities at the works of the specialist firms. We certainly do not propose to duplicate these facilities elsewhere at public expense."

Mr. Sandys in his speech also made reference to the electronics industry as a spearhead of technical progress in a scientific age. With the development of space research, newer and still more exciting opportunities were opened up before the industry. Saying that defence orders would continue to provide a firm foundation for many aspects of the electronics industry's work, he made a strong plea that increasing attention should be paid to civil applications.

It was important, he added, that we should press ahead with developments in which Great Britain had a lead. In the field of aviation, for example, we had developed a system of automatic blind landing which would enable a larger number of

aircraft to be handled in safety in the congestion around airports. This was a vital problem and we must see that we stayed in this particular lead.

In his address, Mr. Hinton had explained that the Electronic Engineering Association represented the "electronic capital goods" section of the industry. In addition to sound and television broadcast equipment this comprises radar, radio navigational aids, electronic computors, industrial electronic control equipment, industrial television equipment, and electronic instruments. This section of the electronics industry had a gross production of about £160m. in 1959, employed about 120,000 people, and had direct exports worth between £26m. and £30m. It had ploughed back £13m. into research and development.

Fairey Engineering Changes

FOLLOWING the recent sale of Fairey Aviation, Ltd., to Westland Aircraft has come news of changes within another Fairey subsidiary—Fairey Engineering, Ltd. This company has three principal components; one is at Hayes, covering aircraft hydraulic power controls, industrial hydraulics, and nuclear engineering work; another is at Heston—the headquarters of the company—covering guided weapons, pilotless target aircraft repair and maintenance, nuclear reactor design, and experimental nuclear equipment and research; at Stockport the third section deals with plastics machinery, machine tools, petroleum equipment, nuclear engineering, and nuclear reactor components.

Mr. L. R. E. Appleton.

Mr. L. R. E. Appleton, O.B.E., M.A., M.I.Mech.E., F.R.Ae.S., has been appointed managing director of Fairey Engineering, Ltd.; and Mr. P. J. Duncton, B.Sc., A.R.C.S., D.I.C., A.F.R.Ae.S., F.Inst.Ph., becomes general manager, Heston. Mr. H. G. Gregory, M.I.Prod.E., remains a director and general manager of the Stockport factory.

Joining Fairey Aviation from Hawkers in 1947 Mr. Appleton became the company's chief technician in 1949. He was appointed chief engineer of the weapons division in 1950. In 1959, when Fairey Aviation was reorganized as a Holding company—The Fairey Co., Ltd.—with 10 subsidiaries, of which Fairey Engineering and Fairey Aviation were two, he became a director of Fairey Engineering.

Mr. Duncton joined the Heston Division of Fairey Aviation in 1948 and until 1957 was concerned entirely with guided weapon design and development. Since then he has been instrumental in building up the nuclear engineering work of the company. He was appointed to the board of Fairey Engineering, Ltd., in November, 1959.

Mr. Gregory joined Fairey in 1943 as general manager of the Northern Group of Fairey factories. He was made a director of Fairey Engineering, Ltd., in April, 1959.

Sir Frederick Bowhill

AS we briefly recorded last week, British aviation lost a great airman on Mar. 12 with the death of Air Chief Marshal Sir Frederick Bowhill, G.B.E., K.C.B., C.M.G., D.S.O. and Bar. He had had a long and distinguished Service career and from 1946 to 1957 was chief aeronautical adviser to the Ministry of Civil Aviation—later M.T.C.A.

Born in 1880, in India, he was educated at Blackheath and had an early ambition for a career in the Royal Navy. In this he did not at first succeed but nevertheless followed his inclination for the sea by going to H.M.S. "Worcester" and spending some years in the Merchant Service. In 1898, however, he was commissioned in the R.N.R. as a midshipman, and by 1911 had risen to the rank of lieutenant. He joined the R.F.C. Naval Wing in 1912, learned to fly at Salisbury Plain and obtained his pilot's certificate in January, 1913. With this he started a long and close connection with Service aviation.

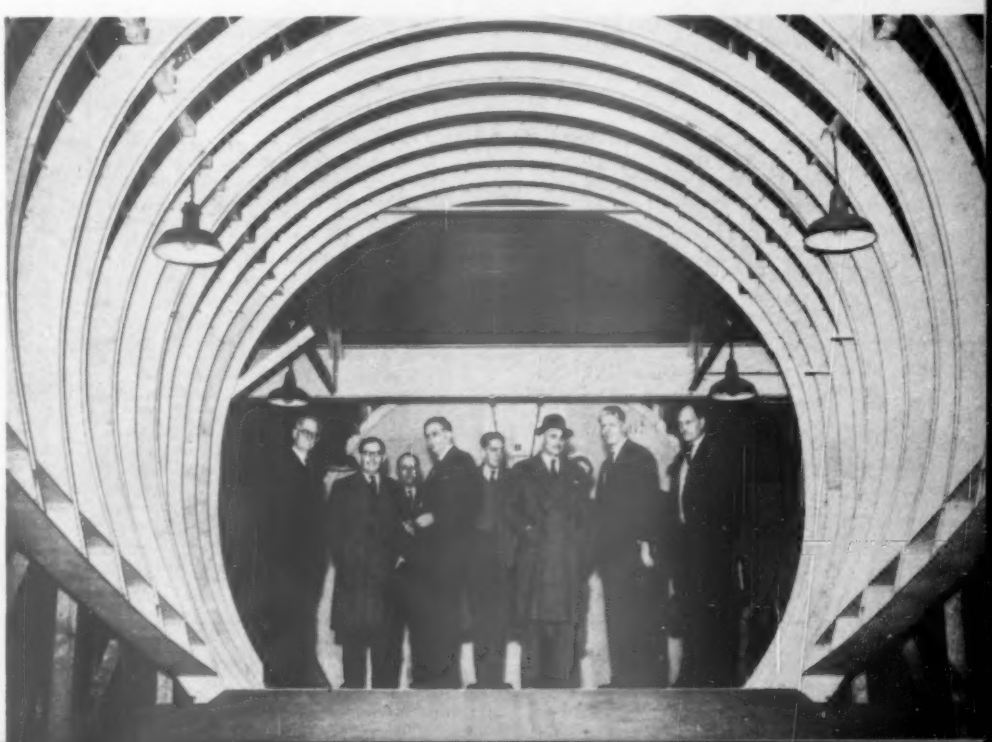
After a spell at the R.N.A.S. flying school at Eastchurch at the outbreak of the War in 1914 he was given command of the seaplane carrier "Empress." The following year he went to the Admiralty to organize a seaplane unit for Mesopotamia —which he subsequently commanded.

In 1919 he was given a permanent commission in the R.A.F. as wing commander and served in the Middle East. In 1921 he was appointed chief staff officer in the Coastal Area—which later became Coastal Command. From 1925 to 1929 he again served in the Middle East before returning to the Air Ministry to become Director of Organisation and Staff Duties.

Appointed A.O.C. Fighter Area (now Fighter Command) in 1931, he was promoted Air Vice-Marshal in July the same year. Two years later he returned to the Air Ministry—this time as a member of the Air Council as Air Member for Personnel. In August, 1937, he was appointed A.O.C.-in-C. Coastal Command.

Upon his retirement after the War, Sir Frederick spent a year as the U.K. Member of Council to P.I.C.A.O.—the forerunner of the International Council for Aviation Organisation. And he continued this link with civil aviation affairs in 1946 when he went to M.C.A.; he retired from the Ministry in 1957 and was succeeded as chief aeronautical adviser by Air Marshal Sir Charles Guest.

Notwithstanding his intense interests in aeronautical matters, Sir Frederick never lost his initial love for the sea and his early connections with the Merchant Service. These close ties were in fact underlined in 1945 when he was elected Master of the Honourable Company of Master Mariners—a unique distinction for a distinguished airman and sailor.



BRITANNIC INSPECTION.—A party of senior officers from the War Office recently visited Shorts and inspected the Britannic rear-fuselage mock-up. Left to right:—Rear Admiral Sir Matthew Slattery; Maj.-Gen. H. M. Liardet, Director General Fighting Vehicles; Capt. H. St. J. Fancourt; Mr. C. D. Hatton; Maj.-Gen. R. K. Exham, Director of Land/Air Warfare; Maj.-Gen. D. G. Moore, Director of Weapons and Development; Mr. H. G. Conway; and Maj.-Gen. G. C. Hopkinson, Director Royal Armoured Corps.

Aviation News in General

ABLE-STAR.—A new version of the Able upper-stage rocket with double the burning time (4 min.), and start and restart capability at altitude, is being developed by Aerojet-General. Thrust has been improved from 7,800 to 8,000 lb.

MINI-TRANSIT. — Weight of the Transit navigational satellite is being reduced from 270 to 50 lb. to permit launching by the low-cost Scout, 4-stage, solid rocket, instead of Thor-Able.

ROCKET SYMPOSIUM. — Another joint symposium is being arranged between the Royal Aeronautical Society, the British Interplanetary Society, and the College of Aeronautics. Covering all aspects of rocket propulsion (liquid and solid), with particular stress on British work, it will be held at the College of Aeronautics on Jan. 6-7, 1961.

ROCKETS AND SPACEFLIGHT.—The 9th Symposium on Rockets and Spaceflight of the German Rocket Society will be held at Maschsee Gaststätten, Hanover, Germany, from Aug 26-28, 1960.

INFLATABLE SPACE-STATION.—Expandable fabric structures able to withstand high temperatures, extreme cold, and vacuum conditions in space, have been developed by Goodyear Aircraft Corp. Launched from the carrier rocket as a small package and inflated in orbit, the flexible structure could be made rigid by applying a quick-setting plastic foam.

TIROS I.—A Thor-Able rocket is being prepared at Cape Canaveral for launching the first 170-lb. Tiros meteorological satellite. Satellite contains two small TV-cameras to scan Earth's cloud cover, and infra-red detectors to measure global heat distribution.

INTEGRAL ORDERED.—A prototype Breguet 941 Integral high-wing STOL aircraft was ordered by the French Air Ministry on Feb. 22. It will be powered by four Turboméca Turmo IIID turboprops with Ratier-Figeac propellers and will have a special Messier Jockey landing gear. Breguet hope to demonstrate the 44,000 lb. Integral at the 1961 Paris Aero Show.

CANADIAN SATELLITE.—First Canadian-built satellite, to be used for radio-propagation experiments, will be made largely of aluminium and glass fibre, with banks of solar cells fitted around its 42-in. dia. midsection. Weighing about 200 lb., the satellite is expected to be launched into a polar orbit by an American Thor-Delta rocket in 1961.

NIPPER APPROVED.—The Popular Flying Association has approved the Tipsy Nipper for amateur construction and for the issue of the P.F.A. Permit to Fly. This follows flight tests by the P.F.A. and evaluation of the aircraft by its Groups. (More news of the Nipper is on page 390.)

HELIPORT AT BRIGHTON. — An experimental heliport on Brighton seafront has been the subject of a recent recommendation by the Brighton Planning Committee.

ANGLO-GERMAN TURBOJETS.—Rolls-Royce, Ltd., has signed an agreement with Maschinenfabrik Augsburg-Nurnberg AG. of Augsburg, Germany, for the joint development of small jet engines. Reference was made to this collaboration in our issue of Feb. 5.

RUNWAY CLEARANCE. — A Dakota which recently crashed and obstructed the main runway at Entebbe, Uganda, was lifted in 90 minutes using R.F.D. Airbags and towed away. According to the chief aerodrome fire officer, the runway would have been closed for at least 24 hr. if Airbags had not been available.

CONNECTION SEVERED.—Sqn. Ldr. Neville Duke, D.S.O., O.B.E., D.F.C. and two Bars, A.F.C., A.F.R.Ae.S., has stated that he is no longer associated in any way with Parman Aircraft Supplies, Ltd., of Horley, Surrey.

Cunard Buys Into Air Transport

A CONTROLLING interest (about 60%) in the Eagle group of companies is to be acquired by The Cunard Steam-Ship Co. This move, announced on Monday, serves to give Cunard its first interest in air transport, and also confirms the continued existence of Eagle as a separate operating entity. In the recent moves towards mergers among the independent airlines, the future of Eagle had not been clear.

Full details of the Cunard-Eagle deal have still to be worked out, but it is known that the individual Eagle companies will continue under their existing identities. The operating companies in the U.K. are Eagle Airways (scheduled services) and Eagle Aviation (charters, inclusive tours and trooping). These two companies share three DC-6Cs, 11 Vikings and a Britannia 318 leased from Cubana. Eagle Airways (Bermuda) and Eagle Airways (Bahamas) share two Viscounts for scheduled services in their local areas. Other companies are Eagle Aircraft Services and Eagle Overseas Airways. During 1959, the Eagle companies flew 223 million passenger-miles.

The Cunard company is the seventh major shipping line to link with a British independent. The others are Furness Withy and Co., Ltd., and Blue Star Lines, each with a one-third interest in Airwork, now merged with Hunting-Clan Air Transport, in which British and Commonwealth Shipping and Hunting and Son each have a 50% interest; P. and O. Steam Navigation Group with a 70% share in B.A.S. (Silver City); and the Bibby Shipping Line with a large minority interest in Skyways.

ALLISON RB.163s?—According to a U.S. report, negotiations between the Allison Division of General Motors and Rolls-Royce, Ltd., may lead to Allison production of the ARB.963 by-pass engine under licence. The ARB.963 is said to be a development of the Rolls-Royce RB.163 in the 12,000-lb. thrust class.

FRENCH GLIDER.—Testing of the experimental performance glider Merville S.31 is still going on under the supervision of test pilot Pierre Bonneau. Designed by Cartier and constructed by the Merville Co., this single-seat glider made its maiden flight on Jan. 11 at Chavenay.

MICROCELL CHANGES. — The Commercial Engineering Division of Microcell, Ltd., has been formed into a subsidiary company known as Microcell Engineering Limited. The board comprises: Mr. Henry Kremer, Mr. J. J. Molins, Mr. L. R. Rutherford, Mr. L. Avis (technical director), and Mr. D. J. Dolamore (works director).

SMITHS APPOINTMENTS. — Mr. G. B. G. Potter, B.Sc., M.I.Mech.E., F.R.Ae.S., is to direct and co-ordinate Smiths aviation research and engineering whilst retaining the managing directorship of the Divisions of S. Smith and Sons (England), Ltd. Mr. K. Fearnside, M.A. (Cantab.), A.M.I.E.E., A.F.R.Ae.S., of Smiths Aircraft Instruments, Ltd., will be directly responsible to Mr. Potter for Smiths Aircraft Instruments, Ltd.'s research and engineering; he has also been appointed director of research and engineering of the company. Mr. G. G. Robers, M.Sc. (London), F.R.Ae.S., remains technical director of Smiths Aircraft Instruments, Ltd., and, as such, will assist Mr. Fearnside in his new appointment.

DOWTY ROTOL.—The engineering department of Dowty Rotol, Ltd., has been reorganized. From Apr. 1, Mr. L. G. Fairhurst will be the technical director of the company. Under him will be the Arle Court Design Department, headed by Mr. A. A. J. Willitt as chief engineer, dealing with traditional Dowty products; and the Staverton Design Department, under Mr. E. Danvers as chief engineer, dealing with the traditional Rotol products. The former design activities of British Messier will be absorbed within the Arle Court Design Department.

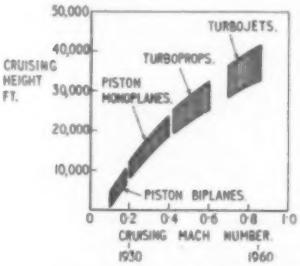
VENNER CHAIRMAN.—Mr. Edward Tauchert, M.I.Mech.E., F.B.H.I., has been elected chairman of Venner, Ltd. He was appointed managing director of the company and its subsidiaries in October, 1958, and will continue in this capacity as well as being chairman.

NAPIER APPOINTMENT. — Mr. Andrew Garratt has been appointed public relations manager of D. Napier and Son, Ltd. He succeeds Mr. C. G. Hollowell, who is now joint deputy publicity manager (general) of the English Electric Co., Ltd. Prior to joining Napier, Mr. Garratt was with the English Electric Publicity Department and responsible for the company's aeronautical advertising.

What Sort of Supersonic Transport?

Ex-S.T.A.C. Chairman Surveys the Problem.

SECRECY has surrounded British work on supersonic transports ever since the S.T.A.C. (supersonic transport aircraft committee) began its work more than three years ago. Not until last week were some authoritative British views revealed when Mr. M. B. Morgan lectured to the Royal Aeronautical Society on "Supersonic Aircraft—Promise and Problems." Mr. Morgan, now scientific adviser to the Air Ministry, was the chairman of S.T.A.C. until he left the R.A.E. Although he was giving his personal views, they were obviously based on much of the work done by S.T.A.C.

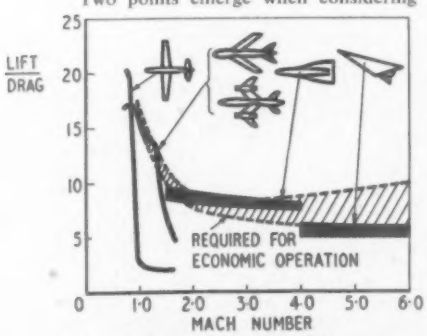


Operating speeds and heights of transport aircraft, 1920-1960.

In the discussion after the lecture members of the industry implied that the British Aircraft Corporation, one of the two airframe groups with supersonic study contracts, favours the Mach 2.2 aluminium-alloy aircraft, but that Hawker Siddeley, the other group, is more interested in higher speeds.

Mr. Morgan began by surveying progress during the past four decades. As the speed/height diagram on this page shows, airliners cluster into a number of families, each following the other. The four groups are biplanes, piston-engined monoplanes, turboprop transports and then swept-wing turbojet transports. Costs per passenger mile have decreased and thus the newer types have tended to drive out the old. There has been no pause for consolidation because air transport is a very competitive field. The development of airliners has not run up against a technical brick wall, as has happened with railways and surface ships.

Two points emerge when considering the development of long-range subsonic turbojet aircraft. The golden rule for economy seems to be to make the aircraft as big as you dare and then to fill it. The other point is that considerable economies are possible if high approach speeds are accepted.



Lift/drag ratios needed for efficient supersonic transports and their probable configurations. The wideness of the lift/drag band at high speeds reflects uncertainty about structural and powerplant parameters.

Much British work has been done on supersonic military projects, both aircraft and missiles; if a case can be made for entering the supersonic civil business, Britain should be well placed to take the step.

As far as propulsion is concerned, the overall efficiency of the turbojet engine rises with Mach number up to about Mach 2.5. At this stage cooling and engine materials present increasing problems. Above Mach 3 the ramjet carries on where the turbojet leaves off; the use of ramjets demands some form of mixed powerplant, because turbojets are still needed for take-off and landing.

Aerodynamics

The aerodynamic problem is to find shapes giving a good cruise lift/drag ratio combined with tractable take-off and landing characteristics. A variety of aerodynamic approaches emerge depending on the cruising speed chosen.

Up to about Mach 1.2 drag can be minimized by increasing sweepback, judicious choice of twist and camber, and the careful shaping of wing-body junctions and wing tips. Swept and M-wing layouts can postpone the catastrophic reduction in L/D ratio. Economic aircraft might be produced which were straightforward extensions from current Mach 0.8 swept-wing transports, but which would cruise 50% faster.

TRANSATLANTIC AT M=2*

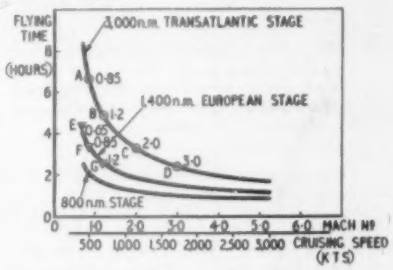
Configuration	Narrow delta
Structure	Aluminium alloy
Powerplant	Turbojet
All-up weight	approx. 300,000 lb.
Payload	approx. 20,000 lb. (100 passengers plus luggage)
Range	London-New York
Cruising altitude	60,000 ft. +
Cruising speed	Mach 2 to 2.2
Descent speed below 35,000 ft.	200 kts. E.A.S.
Approach speed	approx. 140 kts.

Speeds between Mach 1.2 and 1.8 are unattractive because it is difficult to evolve shapes with a sufficiently high lift/drag ratio to counteract the bad effect on economy of lowish speed and engine efficiency.

Speeds between Mach 1.8 and 3.0 are particularly attractive. Long, slender shapes which have a good cruise efficiency can be used; combined with the better engine efficiency and the high productivity associated with high speeds, they give encouraging cost figures. At the lower end of this Mach range it should be possible to evolve shapes with a reasonable landing performance.

As Mach 3 cruise is approached, good landing performance is more difficult to achieve. The choice of cruising speed here depends as much on structure and powerplant considerations as on aerodynamics, because kinetic-heating difficulties increase rapidly between Mach 2 and 3.

Beyond Mach 3 the position is more uncertain because there are fewer research results and less flight experience. The aspect ratio, already small, must be made smaller, with a bad effect on landing performance. A new approach may be necessary with auxiliary lift engines carrying some or all of the aircraft's weight during landing. Alternatively, a variable-geometry scheme might be used to give a substantial increase in wingspan at low speeds.



Variation of journey time with cruise Mach number for stage lengths of 800, 1,400 and 3,000 n.m.

Another possibility between Mach 3 and 5 is the use of shock-interference layouts. The aircraft's body is placed under the wing so that its shock-wave coincides with the wing leading edge. The wing then converts the pressure generated by the body into lift; relatively attractive lift/drag ratios may be possible and the configuration gives acceptable landing performance, because shock-interference layouts have a higher aspect ratio than long slender shapes designed for extreme Mach numbers.

Structures

A Mach 2 transatlantic aircraft carrying 100 passengers will probably weigh about 300,000 lb. at take-off. But, ignoring kinetic heating and the use of novel materials, the basic structural design of large low aspect-ratio supersonic airliners should be no more difficult than for long-range subsonic bombers. Major structural difficulties will be to provide adequate longitudinal stiffness without excess weight and to ensure integrity of a large pressure cabin at heights around 60,000 ft.

Above Mach 2 kinetic heating becomes the main structural problem. Most designers favour a move to steel or titanium structures above Mach 2.2. In addition tyres, transparencies and seals provide increasing difficulties. Allowing for cooling equipment, a penalty in extra structure weight amounting to 2½% of the all-up weight has been estimated in going from Mach 2 to 3. The structures man would undoubtedly be far happier if he could work somewhere nearer Mach 2 than at Mach 3 or above.

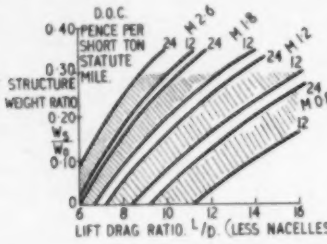
Economics

On the Atlantic crossing a Mach 2 transport will take only three hours, compared with seven hours for the subsonic

* Information on this transport is given in various sections of Mr. Morgan's paper.

jet transport. The saving is four hours, but a Mach 3 transport would only be a further 45 minutes faster. Between London and New York the "block Mach number" of the Mach 3 aircraft is just over 2; for the Mach 2.2 aircraft it is about 1.7.

Two return trips between London and New York can be made daily (as against one for subsonic jets). Not until a Mach 2.9 cruise is reached can 2½ round trips

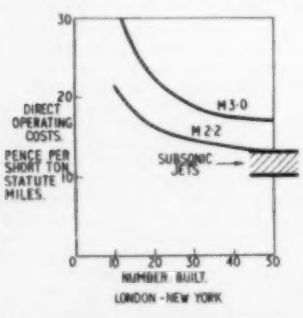


Relationship between the lift/drag ratio and structure weight for London-New York aircraft which have operating costs of 12 and 24 pence per short ton stat. mile.

be made each day. A dozen round trips daily can be made by 12 aircraft if their cruising speed is Mach 0.6 to 1.0, by six aircraft if they cruise at Mach 1.7 to 2.9 and by five if the cruise is above Mach 2.9. Thus there is little saving in fleet size with a Mach 3 cruising speed.

Traffic-potential estimates vary greatly depending on the assumptions made. Estimates of the number of medium- and long-range 100-passenger supersonic transports which could be absorbed on World routes in 1970-75 range from 150 to 500.

If development costs are included, 20 to 30 supersonic aircraft must be built before the cost of development ceases to have a large effect on direct operating costs. Recent British studies show that if 30 Mach 2.2 aircraft were built, the direct operating costs would be comparable with those of existing subsonic jets. The Mach 3 aircraft do not show up so favourably. Even if development costs are ignored,



Effect of development costs on the direct operating cost for Mach 2.2 and Mach 3 supersonic transports.

direct operating costs do not come down to the subsonic figure.

Noise will be a problem with supersonic transports, but provided it is taken seriously from the beginning of a design, there is every hope that during take-off and climb it can be kept down to the same level as present subsonic jets.

Air traffic control may not be as great a difficulty as often thought likely. A typical Mach 2 transatlantic aircraft will come down to 35,000 ft. 120 miles from the airport, and thereafter will fly at 200 kts. E.A.S., when it will be as manœuvrable and controllable as a subsonic aircraft travelling at the same speed. If diverted, it will be able to climb away, cruise subsonically and land at a diversion airport 200 miles away. The greatest demand is likely to be for completely reliable blind-landing aids which allow fuel reserves to be cut to a minimum.

Summing Up

The shorter the range of an aircraft, the less do high cruising speeds pay off in reducing journey time. Medium-range transports designed for stage lengths of 1,500 miles and for flexible operation over shorter ranges will not always cruise at Mach 0.8. Using sweepback techniques, their cruising speed will probably rise to about Mach 1.2 (800 m.p.h.), but operation at higher Mach numbers seems unlikely.

Over transatlantic ranges the first supersonic aircraft to compete successfully with subsonic jets will probably cruise between Mach 2 and 3. A Mach number of about 2 may prove the best: this will be fast enough to reap the beneficial effect of high speed on engine and aerodynamic efficiency, but not so fast as to run into bad kinetic-heating problems. Light alloys could be used and engines which are straightforward developments of current turbojets. Long slender shapes with subsonic leading edges and supersonic trailing edges can give a sufficiently high lift/drag ratio; the aspect ratio gives a sensible compromise between cruise efficiency and reasonable approach speed.

Similar shapes can be extended to Mach 3, but landing speed becomes an increasing problem. Changing from light alloy to steel would surmount kinetic-heating problems. But increasing difficulties would be faced to cut only a further ¾ hr. from the transatlantic time: it would give more uncertain direct operating costs and greater initial costs. But passenger appeal may be high.

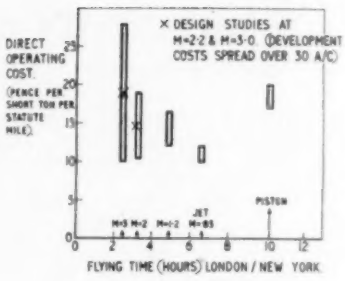
At higher speeds the outlook is more misty. Eventually long-range aircraft may cruise between Mach 4 and 5 using "shock-interference" aerodynamics and ramjet propulsion. At the higher speeds variable-geometry or vertical take-off variants may come into their own.

Discussion

First to speak in the discussion was Sir George Edwards of the British Aircraft Corporation. He said that this was a sensible lecture, more so than most given about this subject on the other side of the Atlantic. Airlines, governments and the military had never faced so much responsibility as over this matter. There was always a relative absence of stability in this field—here was a chance to make things more unstable and ruinous than ever before.

If we British kept within our capabilities, we could produce better aircraft than anyone else. But if we tried to do too much, we might fall on our backs and ruin ourselves in the process.

Mr. Challier, of Rolls-Royce, said that engines for the supersonic transport could be made in the time available; development times would be roughly equivalent to those in the past, but the cost would be greater. But producing a supersonic transport was a difficult job which warranted the development of the best engine that could be made and not a development of an existing type.

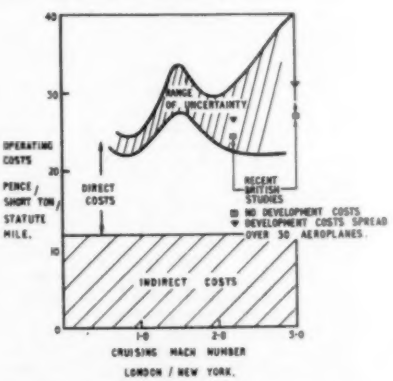


Journey times and operating costs of subsonic and supersonic airliners on the transatlantic route.

Mr. P. A. Hufton, of the R.A.E., said that he was continuing Mr. Morgan's S.T.A.C. job. After much labour they had got lift/drag ratios up to "X," but they were still going after a figure of "X + 1"; the extra "1" would be of the greatest benefit. Discussing the supersonic transport as a whole, he made a plea for a rapid decision on development, citing "Hamlet" as an example of the mess which could result from indecision.

Dr. A. E. Russell, of the British Aircraft Corporation, felt that "to go beyond aluminium alloy for main structure would be running headlong into trouble." Mach 3 materials were difficult to handle and expensive to buy.

Mr. L. F. Nicholson, of the Ministry of Aviation, spoke of his strong belief in the supersonic transport. In Britain we had done much work on this subject, some of it unique, and we had technical achievement to exploit. We needed to start definitely and quickly.



Variation of total operating costs on London-New York route with cruise Mach number.

Mr. G. H. Lee, of Handley Page, Ltd., spoke of a possible way to add the "1" needed by Mr. Hufton to his lift/drag ratio of "X." With a slim-delta transport, 40% of the total cruise drag was skin friction. If by suction techniques this skin friction were reduced by 25%, it was equivalent to increasing the lift/drag ratio by 10%. This would have a big effect on payload and 30-40% more passengers might be carried.

Mr. J. C. Floyd, of Hawker Siddeley, commented that non-cruising cases accounted for about 50% of the fuel load of a supersonic transport. He also suggested that favourable interference effects came in at Mach 2.8 to 3, which were lower speeds than those mentioned by Mr. Morgan.

Air Transport

Cost and Comfort Differentials

THE decisions reached at the composite IATA traffic conferences, which ended in Paris last week, appear to have been the result of a series of masterpieces in detailed compromise. The complete story will not be told until detailed information is issued by the various airlines concerned, but the overall effects are that the majority of fare changes will be deferred until October 1 this year and that a system of cost/comfort differentials has been devised.

In simplest terms it can be said that the new agreements tend towards usefully lower fares in the cheaper classes and unchanged, or slightly higher, fares in simplified versions of "first" class accommodation, with differentials for propeller-driven aircraft in the form of more relaxed seating arrangements or lower fares as the case may be. From July 1, or October 1, according to area, there will be only two basic classes—"first" and a cheaper class which will be described as "economy" or "tourist" according to the wishes of the airlines and the circumstances in different areas.

Since North Atlantic operations have for long tended to provide the patterns—both in fares and aircraft equipment—for other long-haul services, the decisions for this area may serve to indicate the trends in airline thinking.

As from July 1 this year, there will be only two North Atlantic classes—"first" and "economy"—so B.O.A.C. evidently gave way on this point. From May 1 the basic first-class fare will be $500 (£178), one way, New York-London, but operators of propeller-driven aircraft will be able to offer "sleeper seats" at this fare—which is the same as the present "de luxe" fare. For propeller-driven aircraft having normal first-class seating the one-way fare will remain at the present first-class figure of $440 (£157).

The basic turbojet economy-class single fare, new York-London, will be $270 (£96), but from May 1 to September 30 the one-way fare for propeller-driven aircraft will be $20 (£7) less, and from October 1 to March 31 the reduction will be $30 (£11), making the single fare $240 (£86).

So we have, in the two classes, some sign of the long-sought-after downward differential for the slower class of service—though those who study the present fare patterns may find it difficult to decide whether the turbojet fares have gone up or the propeller fares have come down.

The lowest North Atlantic fares—available from October 1 this year to March 31, 1961—will be special 17-day excursion economy rates of $350 (£125) for the return New York-London flight by turbojet and $320 (£114) by propeller-driven aircraft.

On other services the present fares will be retained until October 1. Thereafter some of the first-class fares will be raised and the lower-class services will be called "economy" and the fares will be reduced with seating-comfort differentials for both classes in favour of propeller-driven aircraft, in which present tourist seating densities will, for instance, be retained at the lower fares.

Conway into Service

THE Rolls-Royce Conway entered scheduled airline service on March 17, as the powerplant of Lufthansa's Boeing 707 Intercontinentals which on that day began regular operation across the North Atlantic. The Lufthansa 707-430s are arranged to carry 24 first-class and 120 economy-class passengers, and are flying initially on the Frankfurt-New York route. On April 1, the frequency of this service will be increased to one a day; from mid-May, two services a week to Chicago will be operated by 707 and a Frankfurt-San Francisco service, via Paris and Montreal, will be inaugurated.

Second operator to start Conway-Boeing service will be Air India, who provided last week the first opportunity we have had to sample this newest 707 variant. Apart from the engines, the 707-420 is identical with the Pratt & Whitney-powered 707-320 and it is unnecessary to describe its general features here.

Standard engines for the 707-420 series are Conway 508s at the R.Co.12 rating of 17,500 lb.s.t., but able to produce up to about 19,000 lb.s.t. at sea level on a cold day. The whole nacelle pod (but not the pylon) is produced by Rolls-Royce for the Boeing 707s and the slight change in contour has reduced the drag factor of the -420 by about 1%. This reduction in drag, together with nearly 7,000 lb. more take-off thrust, and an improved s.f.c., gives the 707-420 the best performance of any Boeing.

In general terms, the range of the 707-420 is some 5% better, and, because the s.f.c. is lower, higher cruising speeds can be used over most routes for the same cost of operation. For a given weight, the altitude capability of the 707-420 is improved by 3,000-4,000 ft., and the take-off distance is reduced by 300-500 ft.

FIRST 121.—A complete D.H.121 nose-section is now undergoing pressure tests in a water tank at Hatfield, and the second nose section, illustrated here, will be used in the first production aircraft, to fly late next year.

On the demonstration flight from London Airport to Paris last week, the second Air India Boeing, "Juliet India" (VT-DJI), took off at a weight of 98,000 kilos (216,000 lb.) and was at 1,300 ft. over the end of the 9,700-ft. runway 10R, climbing at about 3,000 ft./min. This was an impressive demonstration of a "noise profile" take-off, with a 25-second ground run. It is generally agreed that the Conway, despite its greater power, is a little less noisy than the Pratt & Whitney engines—though the improvement is not enough to lessen the problem around airports. Inside the cabin, too, the noise level generally seemed to be a little less than in the 707-320. Times of 42 minutes to Paris and 45 minutes back to London demonstrated that over a 250-mile stage the fastest jet airliner can no more than match the block speed of the Vanguard and Electra.

Air India has trained three crews on the 707 to date and plans to have 12 complete five-man crews trained eventually for the four aircraft. The training sequence includes 25 hours on the Curtiss-Wright fixed base simulator at Bombay, and an average of about 16 hours of base flying with a Boeing pilot. Starting early in April, Air India Boeings will operate five services a week between Calcutta, Bombay and London, and in mid-May, the London-New York service will be opened. Boeings are also likely to be used on the route to Tokyo.

The Madrid Incident

THE circumstances of the accident on the night of March 14 at Madrid Airport—to a B.O.A.C. Comet 4 outward bound on the South American run—were such that an official statement should be issued in due course. Such relatively minor accidents, in which no lives have been lost, are usually subjects only for private inquiry and the findings are rarely made public.

It was reported that the port undercarriage collapsed on landing—and this may be all that a newspaper-reading public will retain in their minds, unless they happened to be sufficiently interested to note a passenger's comment about feeling a "bump" during the approach (or the circuit). In fact, the Comet appears to have hit a hill during the first circuit or approach to the airport and to have gone round again at least once before landing. The "bump" was severe enough to cut the two inner engines—presumably through the operation of the crash inertia switches.

Altogether it appears to have been a very lucky affair for all concerned—but the fact that it was so should not provide an accepted justification for treating the incident as a domestic matter. There must be lessons to be learned and these lessons will be valuable to pilots and airline operational staffs everywhere.

Air Transport . . . .

The Short-range Aid Controversy

LAST week's majority decision of ICAO's Air Navigation Commission in favour of VOR/DME is interesting in relation to comments made in the F.A.A.'s interim report on two pictorial presentation methods for use with this system. Although VOR/DME is—subject to final approval by the ICAO Council—favoured, it is becoming obvious that this system will only be finally acceptable if it is combined with a pictorial presentation.

The Commission, sitting in Montreal, voted in favour of VOR/DME by 7-3, with one abstainer and one absent member; Britain, Norway and Canada opposed the decision, which must now obtain a two-thirds majority in the 21-member ICAO Council.

The introduction to the F.A.A. report on the pictorial systems (see last week's issue, p. 334) opens with these somewhat significant sentences:—

"Although the conventional VOR/DME signal is propagated over a large area, present-day aircraft instrumentation permits the pilot to receive precise course (left-right) guidance only when proceeding along selected radials to or from the station. Consequently, the establishment of additional paths or airways means that either the new paths must converge over existing ground stations, or a new series of ground stations must be installed to provide guidance along new paths. Since the installation of additional ground facilities presents technical and economic problems of considerable magnitude, it is logical to seek reasonable alternatives. One of these alternatives is improved cockpit instrumentation to make better use of the information transmitted by existing ground stations."

The study concerned was, within its limitations, a very thorough one and the results are given in detail in the report.

Permanent records of the ground tracks were made by plotting radar information, using a track overlay, and film records were also made of the displays in the aircraft. The systems were examined during transitions from airways to straight-in instrument approaches; during departures to join airways; and during missed-approach procedures.

The conclusions of the report were that pilots are able to fly selected or predetermined terminal-area operational courses using the pictorial displays tested; and that communication workload is lessened for both pilots and controller when aircraft are equipped with pictorial displays.

Anglo-U.S. Agreement Reviewed

EXPANDED route schedules in the Caribbean area are to be recommended by the British and American delegations which have been meeting in Barbados since February 24 to discuss the bilateral Air Transport Services Agreement. The meeting was the latest in a series of joint reviews since the U.K.-U.S. agreement was concluded in February, 1946, of which the last was held three years ago. A number of questions required discussion, especially the operation of Caribbean routes.

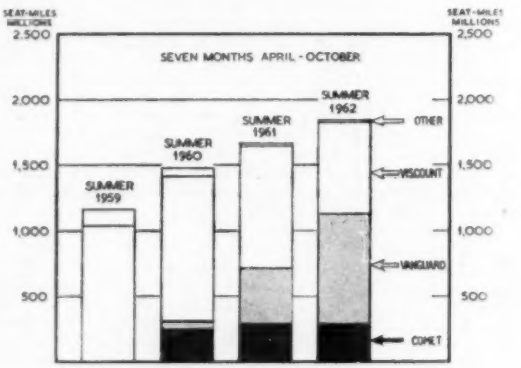
A West Indies delegation attended the Barbados talks and apparently has been successful in its aim of obtaining better services in the area in order to increase tourism.

Further talks are to be held in London in a few weeks' time to continue the discussion of other matters. Proposals for route expansion have been made by both the U.K. and the U.S., and these are being studied before the conference resumes. An M.o.A. statement last week said that the exchange of views in Barbados "had been highly beneficial."

B.E.A. Plans and Progress

IN the summer season of 1962, Comets and Vanguards will produce 60% of B.E.A. seat-miles which, at a total of over 1,800 million, will themselves be 60% above the 1959 summer figure. The figures are an indication of the rapid growth now being planned, and also illustrate the impact upon an airline of quite small numbers of new aircraft. With only seven Comets in use, some 17% of B.E.A.'s seat-miles between April and October this year will be in jet aircraft.

Associated with the increase in capacity—illustrated in the chart—are the new low fares to be offered from April, with



reductions of up to 39% on the lowest fare previously available. "These new fares," says Lord Douglas, "should ensure that 1960 is a boom year for B.E.A.'s traffic, although the revenue rate will tend to fall.

Passenger traffic in February was 26% above the February, 1959, level and load factors increased again. It is now safe to predict that the B.E.A. profit in the 1959-60 year will be greater than in any previous year.

Commercial Aviation Affairs

COMET 4T.—The total of Comet 4s ordered rose to 47 last week when Olympic Airways increased its order from two to three. On Apr. 1, the consortium agreement between Olympic and B.E.A. comes into effect, and thereafter the two airlines will integrate their Comet services to the Mediterranean and Middle East.

MIDDLE EAST AIRLINES.—The M.E.A. order for four Comets, reported in our previous issue (page 333) was finally confirmed on Mar. 15, after the necessary Treasury approval had been obtained for B.O.A.C. to guarantee M.E.A.'s repayments on the loan. One condition of the sale is that D.H. will take the Comets back at the end of five years in part exchange for a fleet of D.H.121s, if M.E.A. decides to re-equip with the newer type.

VANGUARD DEMONSTRATION.—Vickers Vanguard No. 5, which has been flying intensive route proving trials in Europe since the end of February, left the U.K. for demonstrations in New York and the West Indies on Mar. 21. Principal object of this tour, lasting about a week, is to demonstrate the Vanguard to B.W.I.A., which is on the point of ordering new equipment. The outward flight was via Keflavik and the return will be via Bermuda and Gander.

MORE QANTAS 707s.—Government approval has been obtained by Qantas for the purchase of three more Boeing 707s, with turbofan engines, and to convert the seven aircraft now in service to turbofan power in due course. The three new aircraft will have Pratt & Whitney JT3D engines and will be designated 707-138B. They will incorporate the recently developed improvements.

K.L.M. JET PLAN.—On Apr. 16, K.L.M. will become the first airline to operate the DC-8 across the Atlantic. Three services a week to New York will be flown at first, increasing to daily from May 15 and twice a day from Jly. 10. Configuration is for 24 first and 93 economy class passengers. The DC-8 will be introduced on the Amsterdam-Montreal service on Jne. 13 and to Houston and Mexico on Jly. 12. K.L.M. will offer 22% more seat-miles this summer than last.

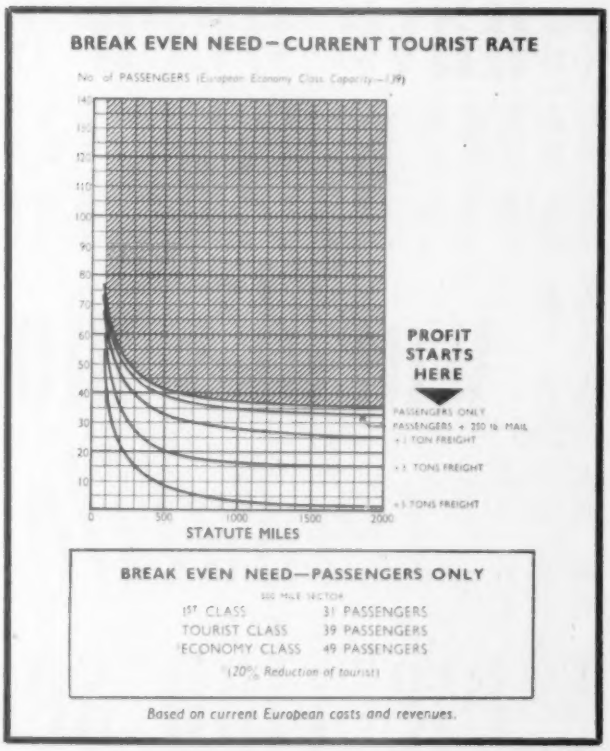
PACIFIC DOPPLER.—United Air Lines are reported to be making operational use of Doppler in DC-8s on the Pacific run between California and Hawaii. The equipment in United's DC-8s is Bendix DRA-12A, which is a frequency modulated, continuous wave Doppler system.

ELECTRA ACCIDENTS.—There were no survivors when a Northwest Airlines Electra, with 57 passengers and a crew of six, crashed near Tell City, Indiana, on Mar. 17 on a flight from Minneapolis to Miami. One wing is reported to have been found about three miles from the remainder of the wreckage. At the C.A.B. hearing earlier this month into the crash of a Braniff Airways Electra last September, failure of the port wing, immediately followed by fire, was indicated.

CRASH IN COLOMBIA.—A Curtiss C-46 operated by Sociedad Aeronautica Medellin S.A. crashed near Medellin on Mar. 19 while making an emergency landing. Of 46 occupants, 25 are reported to have been killed and most of the remainder seriously injured.

Only the VANGUARD

has this low-cost story


BREAK EVEN NEED—CURRENT TOURIST RATE
No. of PASSENGERS (European Economy Class Capacity—139)
PROFIT STARTS HERE
PASSENGERS ONLY
PASSENGERS + 250 lb. MAIL
+ 1 TON FREIGHT
+ 3 TONS FREIGHT
+ 5 TONS FREIGHT
STATUTE MILES
BREAK EVEN NEED—PASSENGERS ONLY
1ST CLASS 31 PASSENGERS
TOURIST CLASS 39 PASSENGERS
ECONOMY CLASS 49 PASSENGERS
(20% Reduction of tourist)
Based on current European costs and revenues.

THE CONCLUSIONS to be drawn from this simple graph are among the most significant ever put to airline operators. It shows at a glance that the Vickers Vanguard will break even on total costs (indirect costs are taken as 100 per cent of direct) with passenger loads no higher than those actually carried by Viscounts today.

With three tons of freight the passenger break even requirement can be as low as 21 people falling to only 8 passengers when five tons of freight is carried for 500 miles. The Vanguard is a profitable aircraft on today's payloads yet it has room for the inevitable expansion of traffic which, even at a modest progress, makes the Vanguard the biggest potential money earner ever built.

In addition to its outstanding economy, the Vanguard is fully competitive in speed (425 m.p.h. cruise), and its turbo-prop flexibility will enable it to maintain schedules as good as any, while allowing for realistic traffic conditions.

Of all the airliners only the Vanguard has all these features

425 m.p.h. cruising • Freight capacity 7/8 tons at normal densities • Full routeing and A.T.C. flexibility • Can use normal existing airfields • Quick turn-round • No airfield noise problems • Ten years' unique Vickers/Rolls-Royce turbo-prop experience . . . ***And it is 'Viscount' quiet.***

VICKERS VANGUARD

FOUR ROLLS-ROYCE TYNE TURBO-PROP ENGINES

• ***The airliner with the biggest profit potential ever offered to the operator***

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

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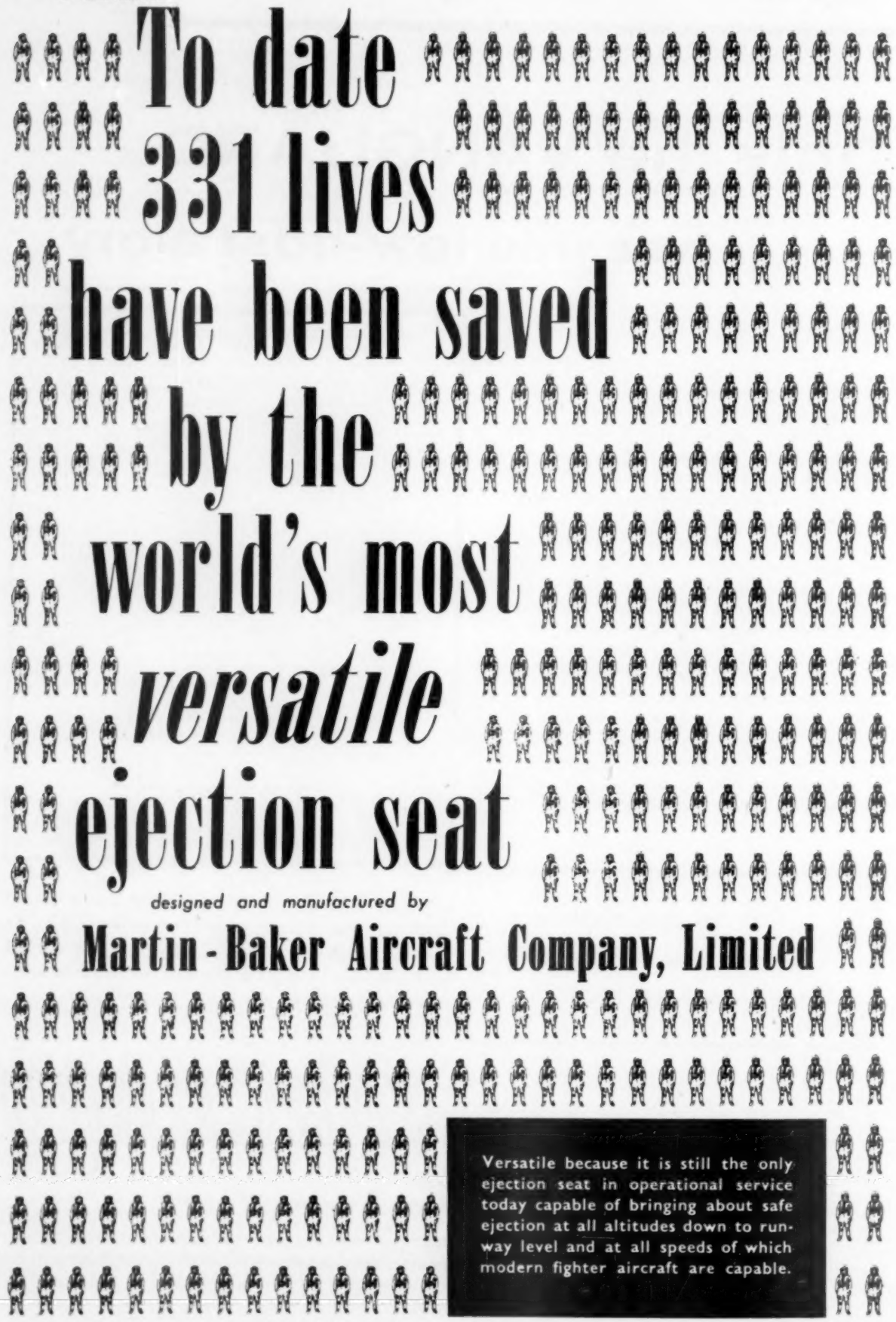

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Versatile because it is still the only ejection seat in operational service today capable of bringing about safe ejection at all altitudes down to runway level and at all speeds of which modern fighter aircraft are capable.

Air Transport . . . .

The Air-freight Business

TWO significant traffic results for 1959 were issued earlier this month. One was for specialist all-freight operations over the North Atlantic and the other was for normal scheduled operations plus all-cargo and charter operations.

Seaboard and Western flew 23,261,000 freight ton-miles over the North Atlantic during 1959—an increase of 73.7% over the figure for the previous year. Swissair's freight traffic for last year showed an increase of 24%—with freight ton-miles as 20% of the total traffic. The increase was most marked on the North Atlantic, with an increase on these sectors of 37% in ton-miles. The good Atlantic results were ascribed to the thrice-weekly DC-6A services between Zurich and New York, via Manchester, and much of the remainder of the general freight increase was due to the greater number of charter flights operated in 1959.

The operating industry as a whole recorded a 37.2% increase in transatlantic cargo tonnage and Seaboard attributes this to increased capacity, to selective rate-lowering and to the "cumulative results of continuous education of the shipping public by all carriers over the years." An interesting fact is that all-freight tonnage over the North Atlantic has increased by 1,213% since 1950, whereas fill-up freight on scheduled services has increased by "only" 268%. In 1959 all-freight aircraft carried 41.6% of the total tonnage lifted over the Atlantic.

The battle for North Atlantic freight will be fought hard this year. During the summer T.C.A. and B.O.A.C., operating under their pooling agreement, will be offering capacity for more than 450 tons every week—most of it as fill-up capacity in the 707s and DC-8s. It will be interesting to see how soon the extra scheduled-service fill-up capacity being offered by all airlines is filled; what effect this increase in capacity will have on the growing demand; and at what point the demand will demonstrate the need for more all-freight capacity.

Sauce for the Goose

NOT unnaturally there have been vigorous protests from travel agents about South African Airways' negotiations with the Overseas Visitors' Club about the possibility of arranging low-fare charter flights between London and the Union. According to reports there would be 30 flights a year, using L-749s or DC-4s initially and DC-7Bs later.

A resolution sent by the Association of South African Travel Agents to S.A.A., the Minister of Transport and the Agency Investigation Board of IATA referred to its "reluctance to continue to support any carriers who assist travel clubs and similar bodies to offer reduced-rate transportation unless such transportation is made available to the general public without enforcing membership of such bodies as a condition of travel. Furthermore, that bonafide travel agents be permitted to accept bookings for such transportation."

For several years the O.V.C. has apparently been offering its members less than half-price travel between Luxemburg and Lourenço Marques—using these terminals because no charter could be arranged between the U.K. and the Union.

The Club has, we understand, recently come to an arrangement with Central African Airways and Airwork for the operation of U.K.-Salisbury flights. The agreement with S.A.A. was due to be signed last month. The scheme would be of great assistance to S.A.A., which will be embarrassed by redundant piston-engined fleet strength when its 707s enter service this year.

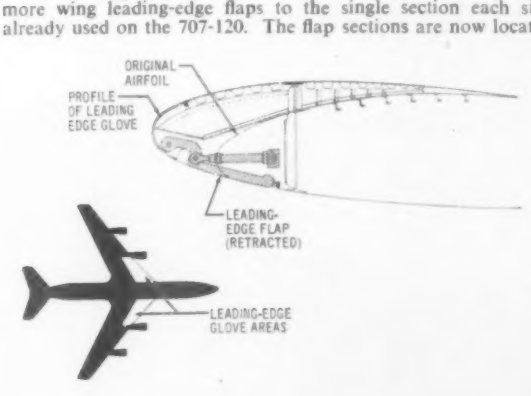
Features of the Boeing 720

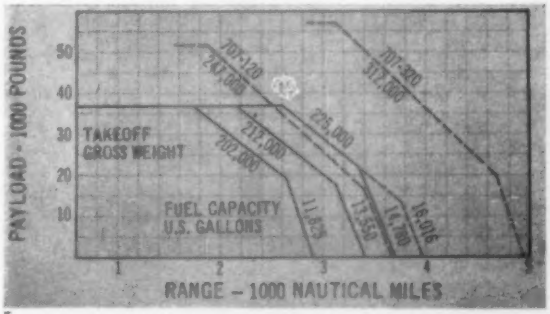
SCHEDULED for first delivery to United Airlines next month, the Boeing 720 is steadily becoming established as the "junior partner" of the Boeing jet transport family. Orders for 720s now total 55 from six airlines; three of these airlines—American, Lufthansa and Braniff—have larger Boeing 707s already, while the other three—United, Irish Air Lines and Western—have made the 720 their first Boeing choice.

First flown on November 23, 1959, the Boeing 720 is outwardly similar to the 707 at first glance; on closer examination, several detail refinements can be observed, all designed to improve the performance or the handling of the 720. Dimensionally, the 720 has the same wing span as the 707-120, at 130 ft. 10 in., but the fuselage is shorter by some 8 ft. (136 ft. 2 in. compared to 144 ft. 6 in.) than the standard 707-120. This same short fuselage is used by Qantas on their 707-120s, which are unique in this respect.

To delay the drag rise and provide a Mach 0.02 improvement in cruising speed, Boeing have developed a leading-edge "glove" for the 720, extending from root to inboard nacelle over some 40% of the chord. By increasing the chord, the "glove"—most of which is fabricated from plastic-reinforced glass-fibre—reduces the effective t/c ratio, and the small increase in weight due to the "gloves" is more than balanced out by the reduced drag to provide a small net increase in range. Block speeds increased by 10-12 knots give a small reduction in direct operating costs.

Another important wing modification is the addition of two more wing leading-edge flaps to the single section each side already used on the 707-120. The flap sections are now located inboard of each pod, and between the outboard pod and wing tip. They hinge down from under the leading edge to make an angle of 100° or 150° with the wing datum line.





These comparative range-payload curves are based on ISA conditions, with a 3% range conservation factor and a 15,000-lb. fuel reserve.

To improve the directional stability at the lower landing and take-off speeds, the fin has been extended upwards by some 40 in.—a modification which is now also being incorporated on all 707s. Another modification which is now universal to the 707s is the full-range rudder boost systems in place of the earlier system which was boosted only at deflection angles over 10°.

The HF fin probe antenna, a distinctive feature of the 707 series, is deleted from the 720, which is unlikely to need HF radio, and a plastic window under the front fuselage provides for Doppler radar if required.

Because the 720 carries fewer passengers in a smaller cabin, one of the three turbocompressors for the cabin conditioning system has been deleted, as also have the fresh-air intakes in the pylons of the outer nacelles. Changes have also been made to the main units of the undercarriage, which are a little smaller overall and of different design in detail.

Several models of the 720 are available, at three different gross weights and with four different fuel capacities, as shown on the payload-range curve. The 225,000 lb. weight is likely to apply only to the 720B with 17,000 lb. s.t. Pratt & Whitney JT-3D-1 turbofans, available in 1962. The initial version of the 720 has the lightweight JT-3C-7, rated at 12,000 lb. s.t.

The Fighting Services

Visiting the R.A.F.

EARLIER this month the Commander-in-Chief of the Jordanian Armed Forces, Lt.-Gen. Habis Majali, visited a number of R.A.F. establishments in the United Kingdom and met Jordanian cadets training with the Service.

Accompanied by Col. A. Bitar, Jordanian Military and Air Attaché in London, and the other officers, the C.-in-C. began his tour on March 11 with a visit to Stradishall. There he was received by Air Vice-Marshal C. H. Hartley, A.O.C., No. 12 Group, and saw a re-arming demonstration on two Hunter F.6s of No. 1 Squadron. During the afternoon the Stradishall Wing demonstrated a mass start, formation flying and a stream landing.

On Monday, March 14, Lt.-Gen. Majali made a tour of the R.A.F. Flying College, Cranwell, with the Commandant, Air Cdre. D. F. Spotswood. He also stayed at the College overnight and attended a cadet dinner night. The following day he visited No. 8 Flying Training School at R.A.F. Swinderby, where the C.O., Gp. Capt. J. D. E. Hughes, introduced him to seven Jordanian pupils undergoing pilot training on Vampire T.11s. He also saw an aerobatic display staged by instructors from the School.

Armament Practice Drones

THE Royal Navy is training personnel to operate and maintain KD2R-5 aerial targets for fleet gunnery and surface-to-air missile practice. Manufactured by Radioplane, a division of the Northrop Corporation, KD2R-5 drones are 200-knot medium-altitude targets with an endurance of more than one hour.

Launched at sea from a ship-board catapult or a zero-length launcher, the drone climbs to altitude and is remotely controlled along a prescribed course. Upon completion of the sortie, the KD2R-5 is recovered by means of a parachute which is deployed upon command, or automatically in case of a hit or malfunctioning. It is equipped with flotation gear.

Preliminary flight training has been completed at the Larkhill Army range and three R.N. Radioplane targets are now at H.M.S. "Osprey," Portland. Upon completion of training, one unit will go to Malta, one will be moved to Singapore, and the third will remain at Portland.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Wg. Cdr. B. C. Bennett, A.F.C., to the Department of the Chief of the Air Staff; Sqn. Ldr. R. M. Jolly to the Department of the Air Member for Personnel, with acting rank of Wg. Cdr.

Fighter Command: Gp. Capt. T. R. Burne, D.S.O., A.F.C., to Headquarters as Gp. Capt., Operations (Control and Reporting); Wg. Cdr. J. P. Beale to Headquarters for equipment duties.

Coastal Command: Wg. Cdr. R. W. Turner, D.F.C., A.F.C., to Headquarters for organization duties.

Middle East Air Force: Wg. Cdr. J. C. T. Downey, D.F.C., A.F.C., to Headquarters as Head of the Middle East Defence Secretariat, with acting rank of Gp. Capt.; Wg. Cdr. E. Burchmore, M.B.E., to R.A.F. Akrotiri, Cyprus, as Senior Technical Officer.

N.B. OCCASION.—Sqn. Ldr. G. C. Doak, C.O. of the Edinburgh U.A.S., was the guest of honour at a recent dinner/dance organized by the Student Mess Committee. He is seen at the back of this group (l. to r.) C/P Shaw, Plt. Off. Woodward, C/P Laing, Flt. Lt. Willams, C/P Doyle and the C.O.

Far East Air Force: Gp. Capt. N. M. Maynard, D.F.C., A.F.C., to R.A.F. Changi to command; Wg. Cdr. M. H. Constable-Maxwell, D.S.O., D.F.C., M.A., to R.A.F. Gan to command.

British Forces Arabian Peninsula: Wg. Cdr. A. D. Button, O.B.E., to Headquarters as Senior Education Officer.

Other Appointments: Gp. Capt. J. H. L. Blount, D.F.C., to Wellington, New Zealand, as Head of the R.A.F. Element of the United Kingdom Service Liaison Staffs; Gp. Capt. R. E. Burns, C.B.E., D.F.C., to the British Joint Services Mission, Washington, for flight integration duties; Wg. Cdr. G. A. Martin, D.F.C., A.F.C., to Ankara as Military Secretary to the Combined Military Planning Staff; Wg. Cdr. G. N. Rushen to Headquarters, Supreme Allied Commander Atlantic, as Director of Aircraft Communications.

More Service News

Longer Term.—Air Marshal Sir Frederick Scherger, K.B.E., C.B., D.F.C., A.F.C., R.A.A.F., has had his appointment of Chief of the Australian Air Staff extended for one year. Appointed in March, 1957, he would normally have retired from the post this month.

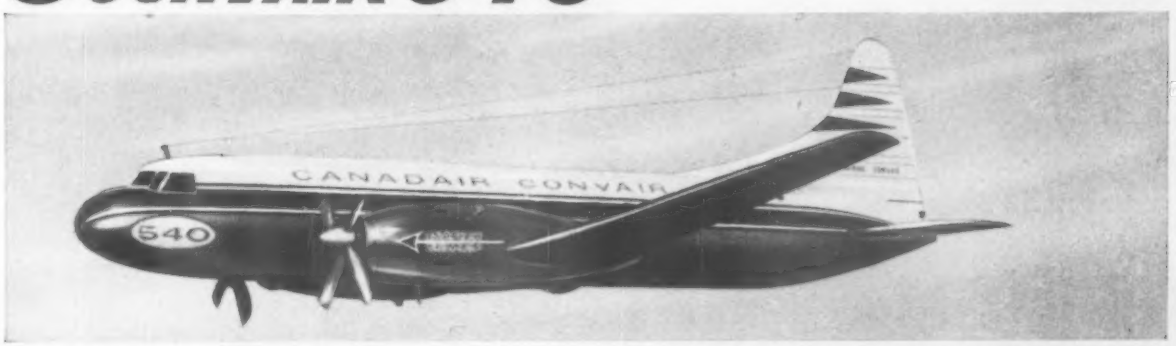
Wg. Cdr. McCarthy-Jones.—A memorial service to Wg. Cdr. C. C. McCarthy-Jones, O.B.E., D.F.C., will be held at St. Clement Danes Church, Strand, London, at 12.00 hrs. tomorrow, March 26. All members of No. 601 Squadron, R.Aux.A.F., who would like to attend are welcome.

No. 84 Squadron Reunion.—The annual reunion of No. 84 Squadron will take place at 19.00 hrs. at the "Artillery Arms," Rochester Row, on Saturday, April 2. Anyone interested should write to Owen Greenwood, Flat 11, 62 Belgrave Road, London, S.W.1.

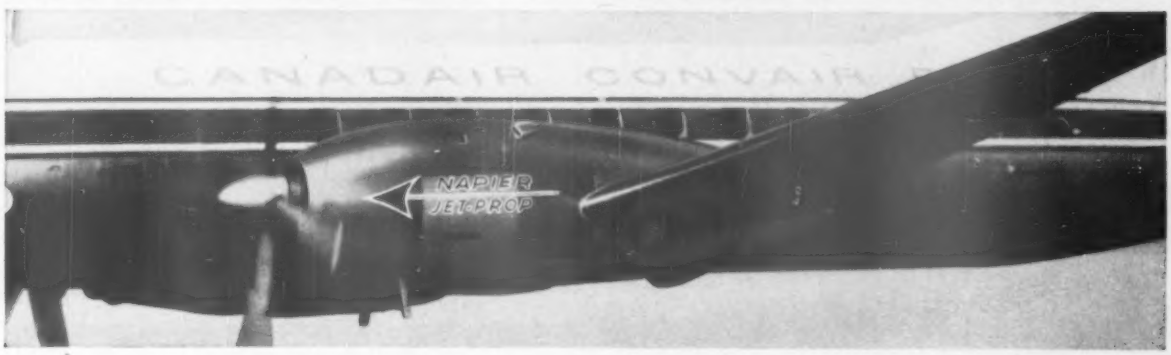
No. 60 Squadron Reunion.—The 7th annual reunion of the No. 60 Squadron officers dinner club will be held at the R.A.F. Club, London, on Friday, April 29. The dress is lounge suits; and tickets, price 13s. 6d. each, may be obtained from Air Cdre. W. Wynter-Morgan, Wentworth, Mount Hermon Road, Woking, Surrey.

ADEN DEFENCE.—Hunters of No. 8 Squadron (Sqn. Ldr. R. Knight) flying over the narrow isthmus at Aden on which lies the R.A.F. airfield at Khormaksar, where they are based. As recorded last week, the Squadron recently converted from Venom FB.4s to Hunter FGA.9s.

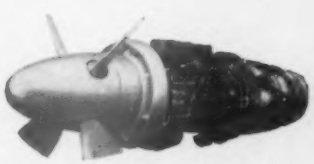
CANADAIR CONVAIR 540



LOOKS FORWARD 10 AIRLINE YEARS



WITH ELAND JET-PROPS



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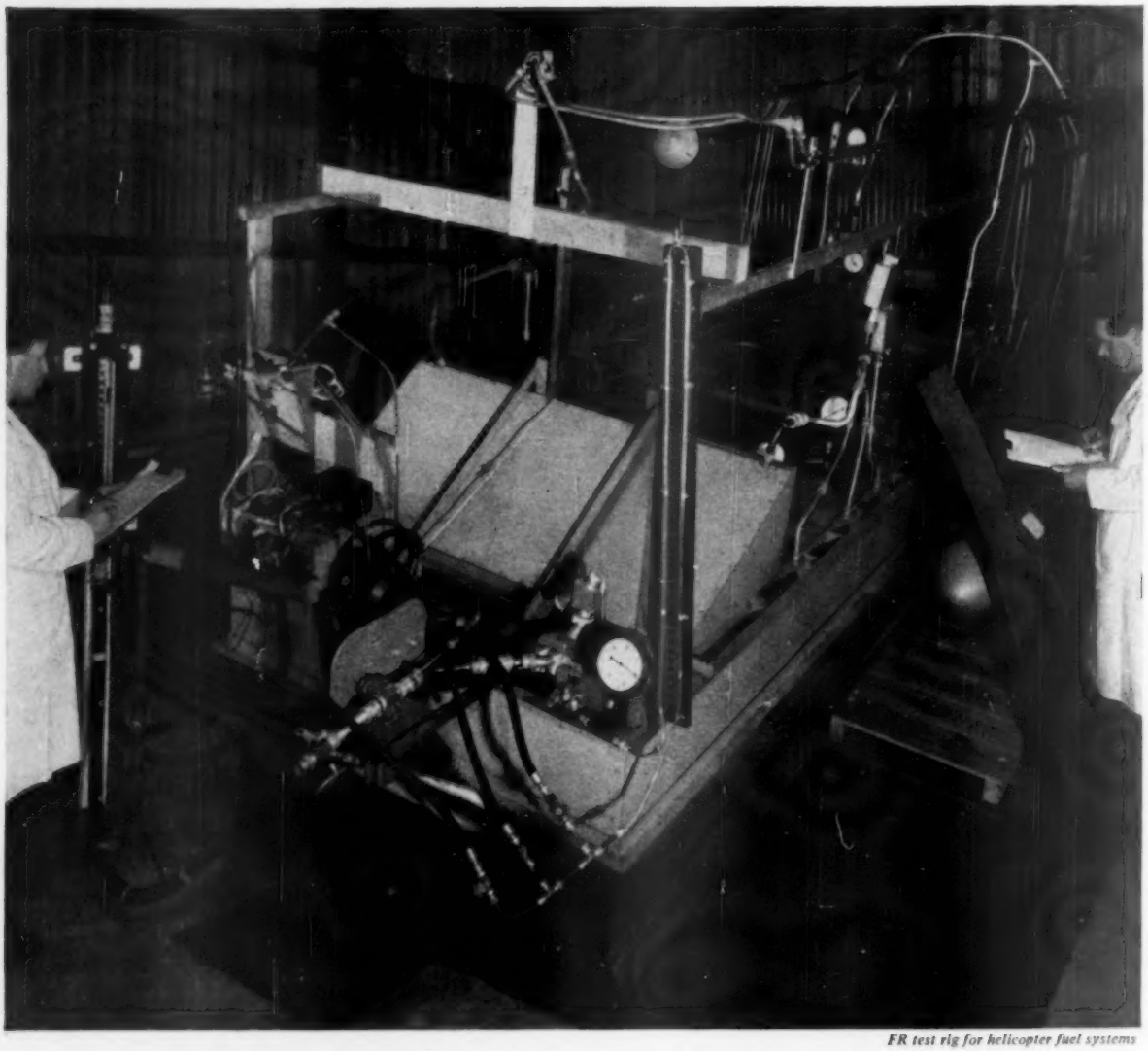

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Astronautics and Missiles

Co-operation in Space Research

WITHIN recent weeks, there has been further evidence of the increasing trend towards international collaboration in space research under the sponsorship of the National Aeronautics and Space Administration. The establishment of a Minitrack station at Slough, Bucks, to supplement the numerous radio-tracking stations already set up in the United States, Australia, South Africa and many other parts of the World, was announced last month. More recently has come news that the Americans are to erect an 85-ft. diameter radio-telescope at Woomera for the purpose of tracking artificial satellites and space-probes from the Southern Hemisphere. The latest example of effective international collaboration in space research has been the contribution by the Jodrell Bank team in communicating with, and tracking, Pioneer V.

From its inception it was clear that the National Aeronautics and Space Administration has regarded co-operation with other nations in the scientific exploration and utilization of space as an important and substantial part of its policy. In a recent lecture to the Institute of the Aeronautical Sciences in New York, Dr. Hugh L. Dryden, NASA's deputy administrator, said that the United States wished the programmes to grow out of the joint interest of America and other nations in space activities.

"We desire a true co-operation," he said, "not a hiring of scientists of other nations to carry out a programme which we have unilaterally determined. We wish to share in the scientific and technical contributions which scientists of other nations can make, by providing them with the opportunity for expression of their own interests and capabilities in joint activities for the benefit of all mankind."

The scope of the NASA-inspired international space-programmes, and the progress to date, were given by Dr. Dryden in his talk to the I.A.S., which forms the basis of this article.

Canadian Participation

In order to support these international objectives within NASA, an Office of International Programs has been established. This is headed by Mr. Arnold Frutkin, who was formerly associated with the programmes of the International Geophysical Year.

It is the function of this office to generate, encourage, co-ordinate, and provide necessary supporting services for NASA's international activities. In so doing, close liaison is maintained with the Department of State, through which all formal international agreements are negotiated, with other interested Federal agencies and committees, and with the scientific community. NASA consults and co-operates with the Space Science Board of the National Academy of Sciences and through it with the International Committee on Space Research (Cospar) which continues the work in this sphere formerly carried on under the I.G.Y.

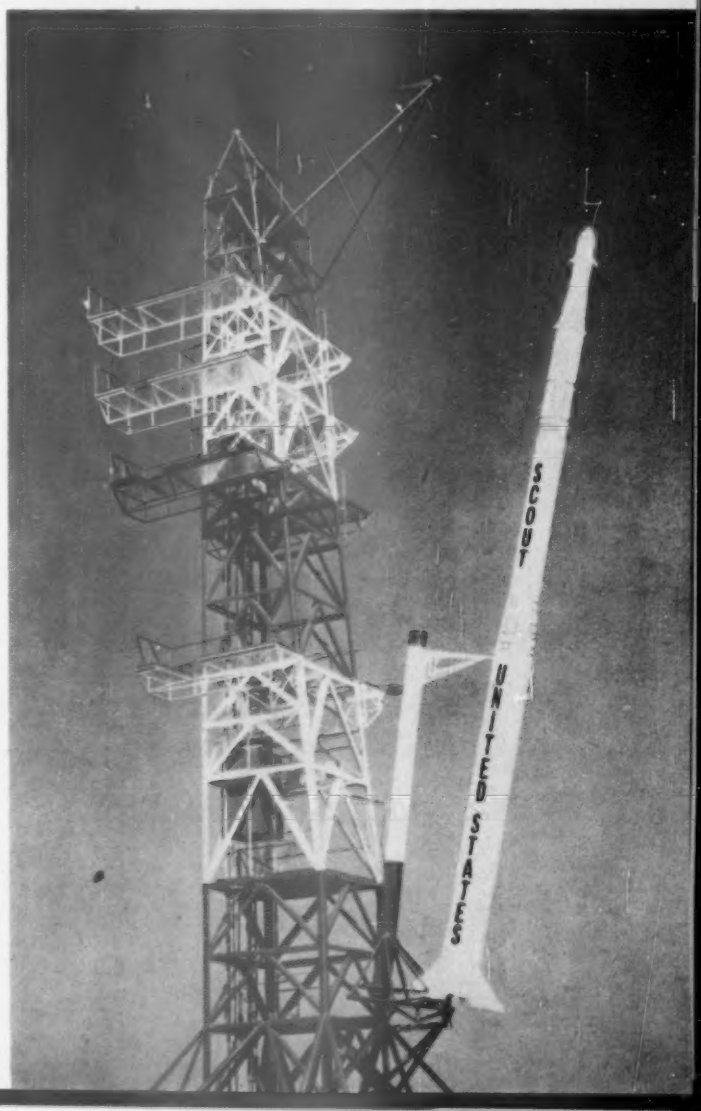
Within a very few months of its establishment, NASA was engaged in preliminary technical discussions with Canadian scientists on co-operation in space activities utilizing sounding rockets and satellites, and was occupied with the problem of making permanent arrangements for the continued operation of Minitrack and optical stations which had been established in many countries during the I.G.Y. on a temporary basis. In March, 1959, NASA authorized the National Academy of Sciences' delegate to Cospar to offer, on behalf of the United States, to place in orbit individual experiments or complete satellite payloads prepared by scientists of other nations. This led almost immediately to preliminary discussions with scientists of the United Kingdom.

By the autumn of 1959 there were reports that many countries in Europe were establishing or considering the establishment of national space committees. Accordingly, in September and October, 1959, informal discussions were arranged abroad with scientists and officials of a number of European countries. These discussions were undertaken by Dr. Dryden with Dr. Homer Newell, then Assistant Director for Space Sciences, and Mr. Arnold Frutkin.

The broad purpose was to acquaint NASA with the developing space interests abroad, and to offer to discuss possible co-operative programmes if and when the space interests in each country became suitably organized and endorsed or supported by their governments or major scientific institutions. In each case, the group described (1) the organization of space activity in the United States; (2) NASA's desire for international co-operation in accordance with the Space Act; (3) the, then, current informal discussions of programmes of co-operation with other countries; and (4) a desirable pattern of co-operation characterized by substantive contributions of instrumentation and services without exchange of funds.

It was also stated that co-operative programmes might ultimately be formulated at the diplomatic level, when required by reason of magnitude or content, but that in all cases technical discussions and agreement on an informal basis should precede formal governmental agreement. It was proposed that Cospar be informed of the nature of any agreed programmes, in order to gain the interest, constructive comment and auspices of the international scientific community.

In mid-November an extensive discussion of a preliminary nature was conducted with Academician L. I. Sedov, President of the Soviet Commission for Interplanetary Communication, Academician A. A. Blagonravov; and V. I. Krassovsky, during their visit to a meeting of the American Rocket Society in Washington. The Soviet scientists expressed interest in co-operation, but stated their belief that such co-operation would have to proceed "step-by-step" from small beginnings. At that time they were willing to discuss only the U.N. Conference on the Peaceful Uses of Outer Space, proposed by



Mock-up of the Chance Vought Scout on the launching tower. This four-stage, all-solid, rocket will be used in international space programmes beginning in 1961.

their representative in the U.N., then under discussion, but since authorized by the U.N. General Assembly.

The NASA international programme was formulated on the basis of these discussions and many other discussions between individual scientists. It comprises four basic types of activity: (1) Exchange of information; (2) exchange of personnel; (3) operational co-operation in tracking and telemetry; and (4) joint programmes.

Under the heading of exchange of information, NASA continues the practices established during the I.G.Y. Announcements of the launching of satellites and space probes are made on a routine basis within a few hours through the Press and through a special World communications network, AGIWARN.

These announcements give orbital characteristics, payload weight, types of instrumentation, and experimental objectives. Preliminary and later results are published in the recognized journals and distributed also through the World Data Centers. These mechanisms have recently been reviewed and somewhat extended by a Working Group formed under the auspices of Cospar.

NASA is participating extensively in scientific symposia, in many ways the chief tool for international scientific exchange. Such meetings allow informal as well as formal exchange and establish the personal relationships indispensable to close and effective collaboration.

Potentially the most significant exchange may well occur at the prospective United Nations Conference on the Peaceful Uses of Outer Space. NASA is preparing to play a central rôle in organizing the U.S. contribution to this hopeful exchange of experience and knowledge.

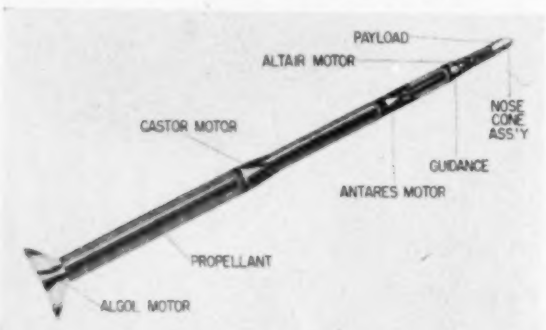
NASA seeks not only to comply with, but to go beyond, the exchanges already agreed on internationally. Thus steps were taken recently to disseminate information to provide an opportunity for scientists in other countries to participate in U.S. experiments, utilizing their own scientific equipment.

For example, the telemetry codes for Explorer VII are being furnished to scientists abroad, on request, for use with locally recorded telemetry. In this way additional data not otherwise available will be contributed to the total scientific results.

Advance notice has been given of Project Echo, the launching of a 100-ft.-dia. inflatable, aluminized sphere which will serve as a passive reflector for communications experiments and which will also permit studies of atmospheric drag at great heights. With this advance information, foreign scientists may prepare the necessary equipment and arrange for such ground-based experiments as are feasible.

A most effective way of exchanging information and experience is through exchange of scientists, said Dr. Dryden. Space science, for example, is not a new scientific discipline. It is more the use of the new tools, sounding rockets, Earth satellites and space probes, by physicists, astronomers, biologists and other scientists to advance knowledge in their own fields, and in broad problems requiring an interdisciplinary approach. Exchange of scientists may be used to provide training and for joint participation in co-operative programmes.

In order to provide an opportunity for scientists from other nations to develop their interests and capabilities for space research, NASA has through the National Academy of Sciences established a number of post-doctoral and senior post-doctoral research associateships at its own laboratories. These associateships provide stipends beginning at $8,000 per year. While open to U.S. as well as other nationals, so far five scientists from other countries—Japan, India, New Zealand and Denmark—have been accepted.



Sectional diagram of the Chance-Vought Scout showing the four "solid" stages and the disposition of the payload and guidance equipment. It will orbit a payload of 150-200 lb. at a height of 300 miles.

Exchanges of scientists will also occur in connection with joint projects. However, at this stage in the building of U.S. teams, considerations of operating efficiency require that some discretion be used in the acceptance of personnel for training. Discussions are in progress with several countries.

NASA's tracking and telemetry operations in other countries now include:—

(1) The Minitrack (radio) satellite tracking stations established during the I.G.Y. in connection with Project Vanguard. (2) The Baker-Nunn (optical) stations established by the Smithsonian Astrophysical Observatory for the same programme and now operated for NASA under grants. (3) Services provided by observing stations of other countries under grant or contract. In addition, these operations will include: (4) a new radio tracking network required for Project Mercury, the manned satellite project, and (5) a deep-space probe tracking network consisting of the present NASA-JPL Goldstone station and two additional steerable radio "dishes" each 85 ft. in diameter.

Existing radio and optical stations constitute an international tracking range based in 10 countries. In Australia, India, Japan, and South Africa the stations are manned entirely by nationals of the host country. In Chile, Ecuador, and Peru the operation is a joint one. The stations in Argentina, Iran, and Spain are operated by NASA. New Minitrack stations are planned for Canada and England, subject to governmental approval.

Radio Tracking

The basic network abroad is supplemented in three instances by contract or grant arrangements. Thus, the largest steerable radio "dish" in the World, at Jodrell Bank in England, has contributed invaluable tracking services, and during the past year has been supported by NASA contract. Grants for tracking and telemetry services, together with necessary special equipment, have gone to the University of Heidelberg in West Germany and to the Radio Research Laboratories of Japan.

At the present time, NASA is in the process of establishing the Mercury network using some existing stations but requiring seven new sites. Negotiations conducted by the Department of State and NASA are in various stages of completion with Australia, Bermuda, the Canaries, Canton Island, Mexico, Nigeria and Zanzibar. At least two of these are expected to be operated by nationals of the host country.

In all, 19 countries or political entities are involved in these network arrangements. NASA intends to encourage participation by qualified nationals of the country in which the station is located to the fullest extent practicable. The global nature of these NASA activities helps to broaden scientific interest, participation, and contribution in the exploration of space.

A further step in international co-operation is joint participation in the design of experiments and in the preparation of payloads for rockets, satellites and space probes. Two projects of this type have been established, and discussions between NASA scientists and their colleagues from many other countries are under way.

As previously indicated, NASA's present philosophy is that proposals by scientists of other countries should grow naturally out of their own interests and capabilities. So that problems of screening competing proposals in the same country may be avoided and assurances of national support gained, it is desirable that they enjoy the sponsorship or endorsement of the governmental bodies or major scientific institutions concerned, as appropriate. Each nation will make and finance its own scientific and technical contributions in truly joint efforts with the U.S. towards mutually agreed objectives.

Agreement has been reached with Canada, represented by the Canadian Defence Research Board, on a joint project to sound the ionosphere from above by means of apparatus carried in a satellite. Canadian scientists are developing a sweep-frequency topside sounder and will provide the antenna and satellite shell. Meanwhile U.S. scientists will develop a fixed-frequency sounder.

Both will be placed in orbit by the United States, the first flight, sometime in 1961, going to the instruments which are first available. This project is suitable for participation in ground observations by scientists of many other nations.

In July, the United Kingdom sent a team under Prof. H. W. S. Massey to discuss a British proposal within the framework of NASA's offer to Cospar. It was tentatively agreed that British scientists would instrument perhaps three satellites for launching over a two- to four-year period by means of NASA's Scout or other vehicle.

Agreement has since been reached for the experiments to be

(*Continued on page 367*)

(*Continued from page 366*)

flown in the first Scout in the summer or autumn of 1961. The experiments fall in the fields of solar radiation, ionosphere, electron density, and cosmic radiation.

The organization of space interests in other countries is in the early stages and programmes have not matured. However, in addition to the U.S., U.S.S.R., U.K. and Canada, six other countries—Australia, Belgium, France, Italy, Japan and Sweden—have established national space committees. Because of the very substantial budgetary requirements of the more ambitious space programmes, there is wide interest in international co-operation.

Interest has been expressed to NASA by the countries just mentioned and by scientists on behalf of Argentina, Israel, New Zealand, Spain and West Germany as well. The interest has been both formal and informal, and includes requests for information exchange, for supplying sounding rockets, for exchange of scientific personnel, and for joint preparation of instrumented satellites for launching by the U.S. Formal proposals have been received from Australia, Italy, Japan, New Zealand and West Germany, in addition to Canada and the United Kingdom.

Rockets and Space-weapons

SPEAKING on "Rockets, Satellites and Military Thinking" at the Royal United Service Institution, Whitehall, London, on March 16, Sir Frederick Brundrett, K.C.B., K.B.E., formerly Chief Scientific Advisor to the Ministry of Defence and Chairman of the Defence Research Policy Committee, had some forthright things to say about Britain's nuclear deterrent policy. He was strongly in favour of continuing the development of the Blue Streak LRBM.

At the time when the Blue Streak concept was originated, he said, it was clearly the most suitable weapon for our purpose.

When we started work on this rocket, no real alternative was foreseeable. One had got to commit oneself to a development programme sufficiently early to fill the gap between the old weapon and the one that was replacing it.

More recently, it had been suggested that submarine-launched or air-launched ballistic missiles—being "solid" and mobile—would be superior to the fixed-site, liquid-propellent, ballistic rocket.

Mr. Khruschev had said that the manned strategic bomber was out of date, and Sir Frederick agreed that fixed missile bases could be destroyed by missiles. But Blue Streak sites could be hardened so as to resist all but a direct hit. He did not see how Russia could be certain of putting out of action a sufficiently high proportion of the West's retaliatory forces in a surprise attack.

In his opinion, Blue Streak would provide a very effective independent British contribution to the Western deterrent until 1970 and probably well beyond. Such a rocket involved a development time of 7-10 years. We could not afford not to continue the development of Blue Streak, he said; we must go ahead and finish it as rapidly as possible.

Sir Frederick thought that only a nuclear-powered missile-launching submarine would do as an alternative, but we could not expect to have a weapon system of this kind before 1970 at the earliest. He favoured the submarine rather than an aircraft as the launching platform because the missile-carrying aircraft "would be very vulnerable." In any case, he said, this type of weapon was still many years away.

On the subject of space-weapons, he could see no future in satellites as bombing platforms; the weapon would have to be carried into orbit and then forcibly ejected. It would be far simpler—and much less expensive—to use a conventional ICBM for H-bomb delivery. A general defence against conventional ballistic missiles was unlikely.

In the speaker's opinion, reconnaissance and communication satellites were the most important from the military standpoint. While he still entertained some doubts about the effectiveness of the reconnaissance satellite, he believed communication satellites would be most promising in long-range telecommunications. A passive satellite network of about 20 spheres established in a relatively low polar orbit would serve for continuous line-of-sight transmissions, the radio energy being beamed on to the spheres and reflected to ground receiving stations.

Answering questions at the end of his lecture, Sir Frederick said he considered surface ships and non-nuclear submarines too vulnerable for use as ballistic missile carriers. Blue Streak hardened sites would not give protection against a direct hit, but otherwise they would afford good protection. Of the possibility of adapting the V-bombers as ALBM carriers, he thought this might be done but bombers were more vulnerable than the nuclear submarine. In the lecturer's view the latter would have more lasting value.

On the theme of the nuclear deterrent, Mr. A. V. Cleaver (Rolls-Royce, Ltd.) said that if we kept changing our minds, we should end up with nothing at all. Three years ago we had turned down the supersonic bomber. After another three years we could easily change to something else. It was essential to maintain the continuity of weapon development. Blue Streak was perfectly adequate for our purposes in the time-scale envisaged.

Sputnik Launcher or Geophysical Rocket?

ONE thing guaranteed to excite the enthusiasm of the Western rocket engineer would be a glimpse of the multi-stage rockets that launched Russia's artificial satellites and space-probes. Thus, it was of more than usual interest to find in the pages of the *Daily Mail*, on Mar. 16, two photographs purporting to be the first to show the vehicle which put Sputnik II and Laika, its dog-passenger, into orbit. The pictures, the paper says, were supplied by Russian authorities and obtained by the U.S. National Aeronautics and Space Administration.

On this page we reproduce a photograph of a Russian rocket which has been available in London since March, 1958. Although it is not a particularly detailed picture, it does show a good similarity with last week's published photographs.

Clearly, the vehicle is propelled by a single rocket engine and almost certainly it employs liquid propellent. It has four aerodynamic fins, and two or more large pods are attached about one-third of the vehicle's length from the base. Again, like the newspaper pictures, the nose of the rocket is preceded by a flared section, giving the appearance of a second stage.

In short, the pictures in the *Daily Mail* show a vehicle bearing a strong resemblance to one of the geophysical rockets which the Russians have been using for many years to launch heavy research payloads, including dogs and rabbits, to altitudes up to about 280 miles. The long tapered nose section, in this case, is not a second-stage rocket but an unpowered detachable head used for recovering the instruments and animal occupants. The flared transition section, which locks on to the single-stage rocket booster, is fitted with a number of extensible petal-like drag brakes; and forward of this is a large compartment housing the recovery parachute.

Next come equipment bays which normally contain a wide range of geophysical instruments, and some vehicles have a pressurized compartment for the experimental animals. Included with the biomedical research equipment is often a ciné-camera for direct observation of the animals' reactions under acceleration and weightlessness.

A thin cylindrical extension to the nose is sometimes fitted which contains a solar spectrograph.

Two rocket vehicles are used for this work, the A-2 which can reach altitudes of about 130 miles, and the A-3 which ascends nearly 300 miles. It is not unusual for payloads of about two tons to be carried for comprehensive scientific measurements (THE AEROPLANE AND ASTRONAUTICS, August 21, 1959, p. 36).

Moreover, it has been the practice to attach jettisonable instrument containers to the sides of the rocket so that upper atmosphere measurements can be made remote from the rocket and its exhaust products. These containers are also recovered by parachute.

An advantage of the Russian technique is that measurements can be analysed directly, without an intervening telemetric stage, thus increasing the reliability of the recorded information.

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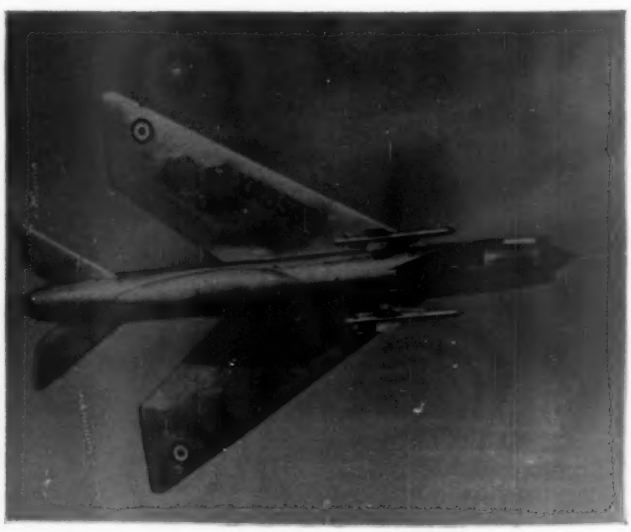
The Lightning reaches a speed of Mach 0.9 in level flight at operational height within 2.5 minutes from brake release. In considerably less than 3.5 minutes it can accelerate from the speed of sound to Mach 2.

At all altitudes the Lightning is highly manoeuvrable and fully aerobatic whether subsonic or supersonic; such outstanding performance makes the aircraft suitable for a number of roles including Ground Attack and Photo-reconnaissance.



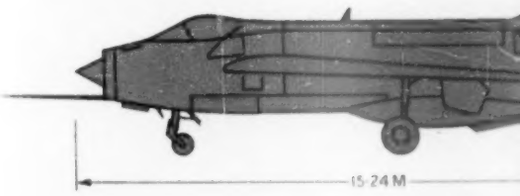
ne "Lightning" has .... *Now*

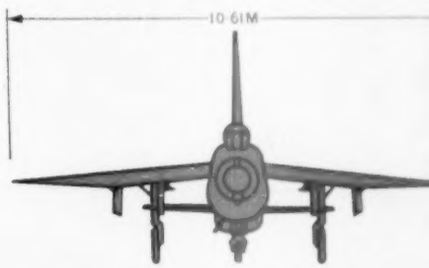
TWIN ENGINES FOR RELIABILITY AND ECONOMY ... Two engines to provide reliability are a vital requirement in a supersonic fighter aircraft.

An added safety factor in the case of the Lightning is the positioning of both engines along the centre-line of the fuselage so that the aircraft does not develop asymmetric characteristics when flying on one engine.

Further reliability on the Lightning is provided by complete duplication of all power control systems and their associated power supplies.

The two Rolls-Royce Avon engines provide supersonic performance without re-heat and afford great fuel economy under appropriate conditions.



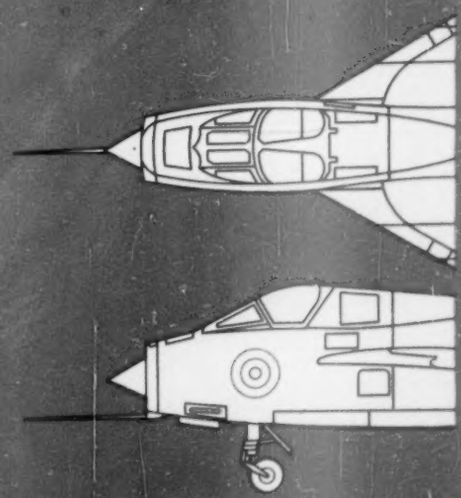


Two-seat version now available

The two-seat version of the Lightning now available has all the outstanding qualities of the single seat version and a comparable performance. It can be used as a trainer, for conversion purposes, or as an operational aircraft ... or the same aircraft can fulfil all these functions.

In its operational role the pilot can give full attention to his instruments while the radar operator takes over fire control responsibilities.

The two-seat Lightning is equipped with the same full navigational and landing aids, airborne search and track radar as are fitted to the single seat version. All controls and instruments including Radar Fire Control are duplicated.



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...at NATO needs—the "Lightning" has .... *Now*

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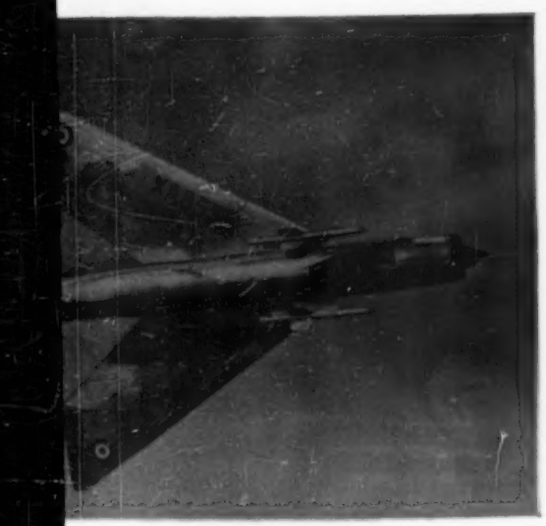
...TANDING PERFORMANCE

...Lightning reaches a speed of Mach 0.9 in level flight at ...onal height within 2.5 minutes from brake release. In ...erably less than 3.5 minutes it can accelerate from the ...f sound to Mach 2.

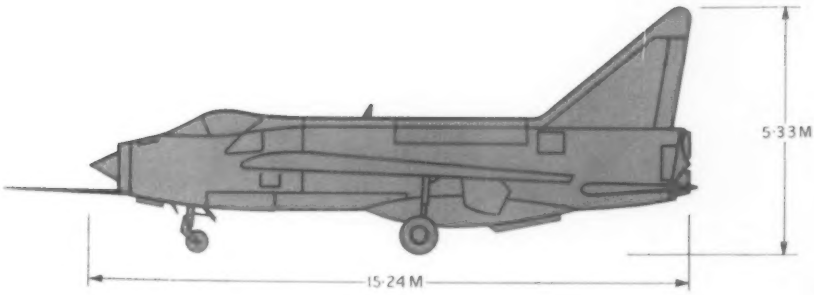
... altitudes the Lightning is highly manoeuvrable and fully ...c whether subsonic or supersonic; such outstanding ...ance makes the aircraft suitable for a number of roles ...g Ground Attack and Photo-reconnaissance.

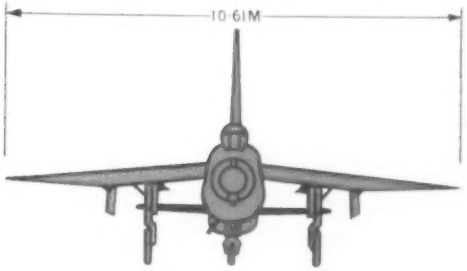


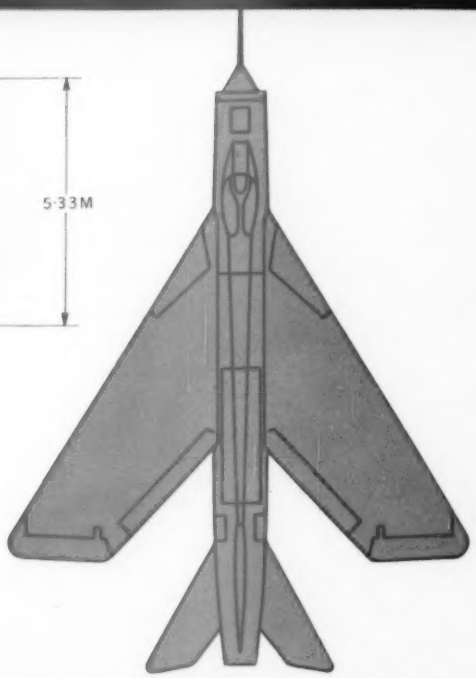
Two-seat version now available

The two-seat version of the Lightning now available has all the outstanding qualities of the single seat version and a comparable performance. It can be used as a trainer, for conversion purposes, or as an operational aircraft... or the same aircraft can fulfil all these functions.

In its operational role the pilot can give full attention to

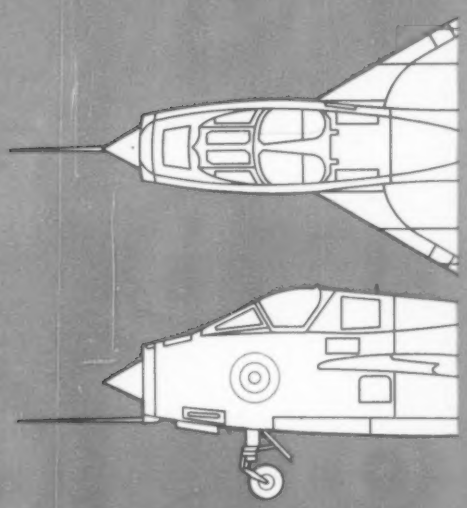






his instruments while the radar operator takes over fire control responsibilities.

The two-seat Lightning is equipped with the same full navigational and landing aids, airborne search and track radar as are fitted to the single seat version. All controls and instruments including Radar Fire Control are duplicated.



AN INTEGRATED WEAPON SYSTEM

The engines, airframe, radar equipment, the electronic aids, the armament, the fire control devices—all were planned from the start to work as a co-ordinated whole to achieve maximum operational performance.

A variety of armaments can be fitted to meet different operational requirements—all are developed within this integrated weapons concept.

INHERENT AERODYNAMIC STABILITY

Ease of control at all speeds is achieved without autostabilisation; the Lightning does not depend upon electronically supplied stability. Autostabilisation is there—but needed only as a refinement in the tracking and attack phases.

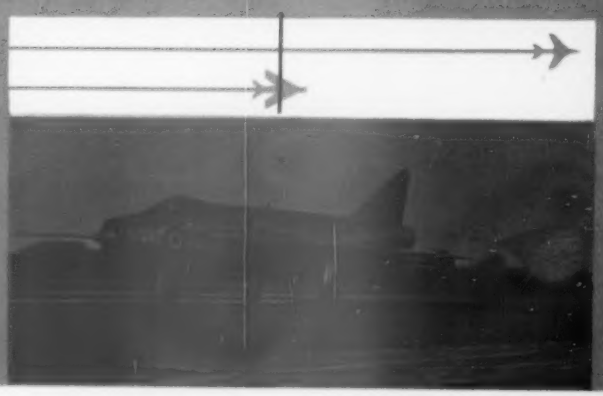
All this has been achieved because the design of the aircraft is such that it is inherently aerodynamically stable and completely free from pitch-up throughout its entire performance range.

DEVELOPMENT POTENTIAL

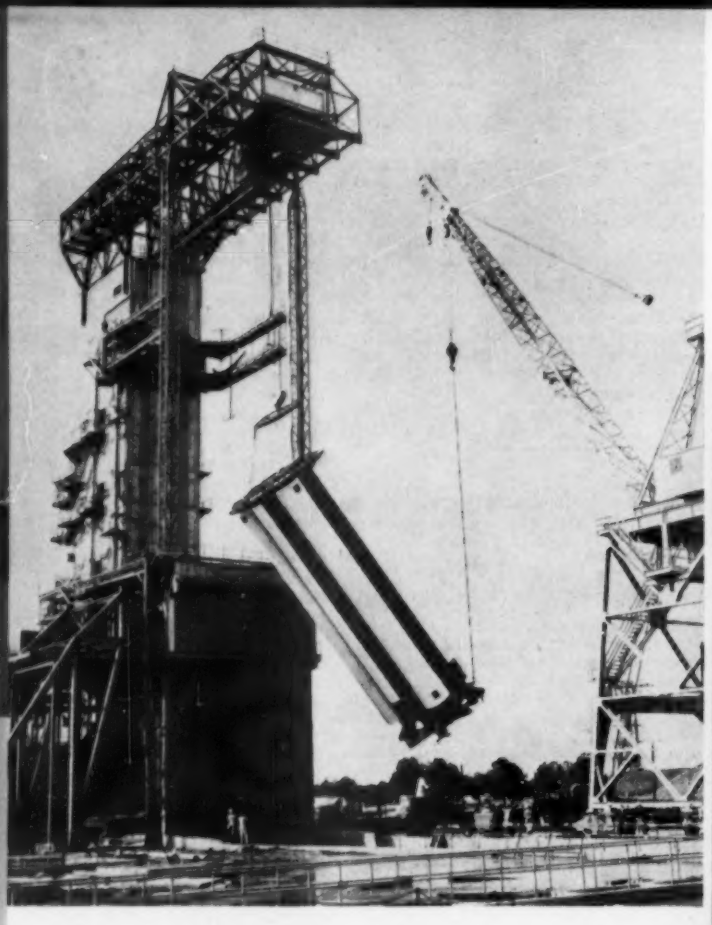
The Lightning is only at the start of its great potential. This basic design offers great possibilities not only for increased performance but also for adaptation to other roles. This potential ensures great economies in operation.

EASE OF LANDING

No complicated landing techniques need be learned nor any extensive runway alterations made, for the Lightning can be landed and brought to rest in 800 yards.



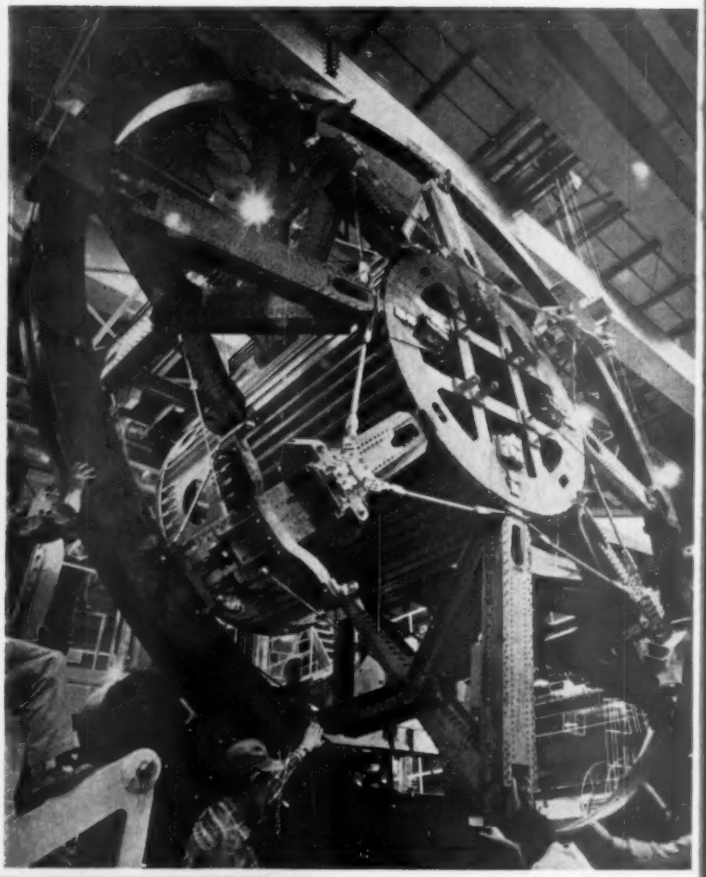
English Electric Aviation Limited Marconi House Strand London WC2

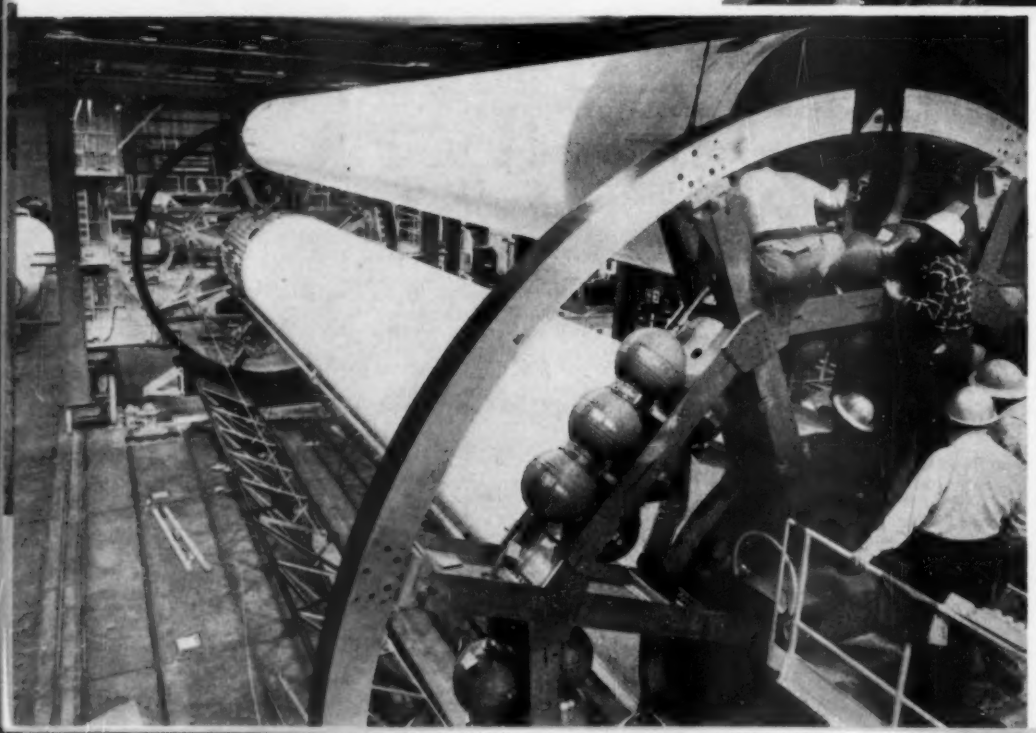


The 80-ft.-long, 22-ft.-dia. Saturn booster (left) is lifted into position in the static test tower. Eight Rocketdyne H-1 liquid oxygen/kerosene engines will be installed on the thrust frame of the booster in the tower.

Space-age Leviathan

Construction of the first Saturn booster of 1.5 *million lb. s.t., which the Army Ballistic Missile Agency, at Huntsville, Alabama, is developing for NASA, is now complete. A long series of static tests will follow. Later, the booster will go by barge to Cape Canaveral where a* 305*-ft. self-propelled servicing gantry is being built. First launching is not expected before the end of next year.*

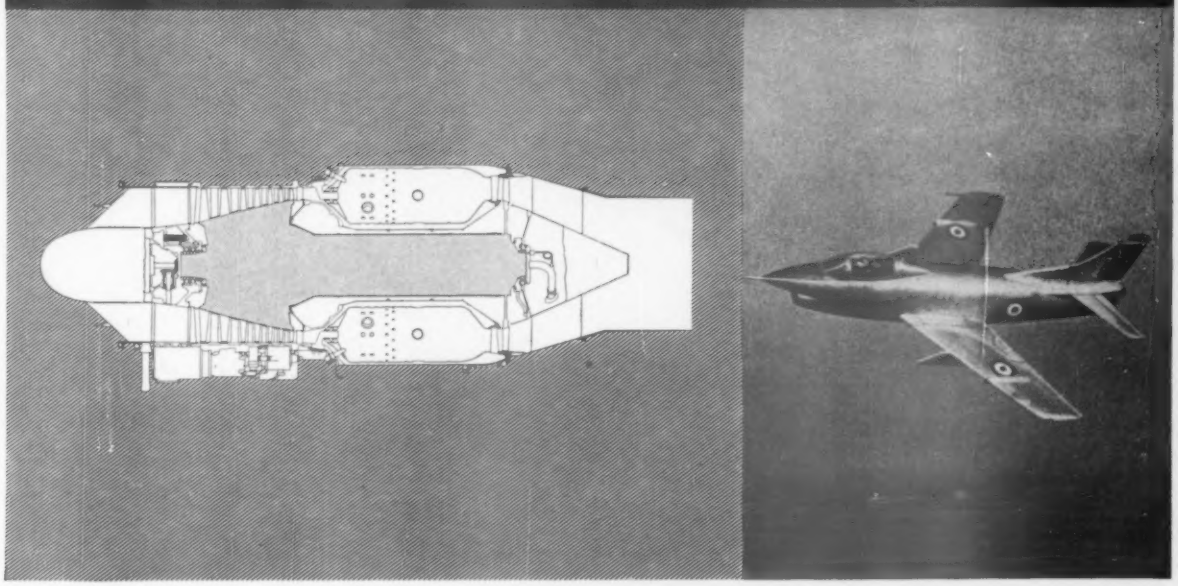




Above, the thrust frame at the lower end of the booster showing the heavy bracing girders and corrugated centre-body construction.

View from the top end of the booster showing the high-pressure spherical containers employed for pressurizing the system after firing begins. One of the eight 70-in.-dia. outer tanks is in place above the central 105-in.-dia. oxygen tank.

Orpheus turbojet - already flying in 6 different aircraft - now reaches 6,810 lb thrust dry, over 6:1 thrust/weight ratio . . .



ORPHEUS 803—general arrangement showing the two-bearing layout.

...ANOTHER ENGINEERING ADVANCE BY BRISTOL SIDDELEY

The design philosophy behind the Orpheus family of engines was based on two conflicting requirements—extremely light weight and exceptional reliability. That these requirements were successfully reconciled is shown by the fact that the Orpheus has been specified in five countries for no fewer than 14 distinct types of aircraft, six of which are already flying. The Orpheus is undoubtedly the most advanced medium-thrust turbojet engine in the world and the latest version, the B Or 12, has more than twice the thrust of the original Orpheus, which first flew in 1955.

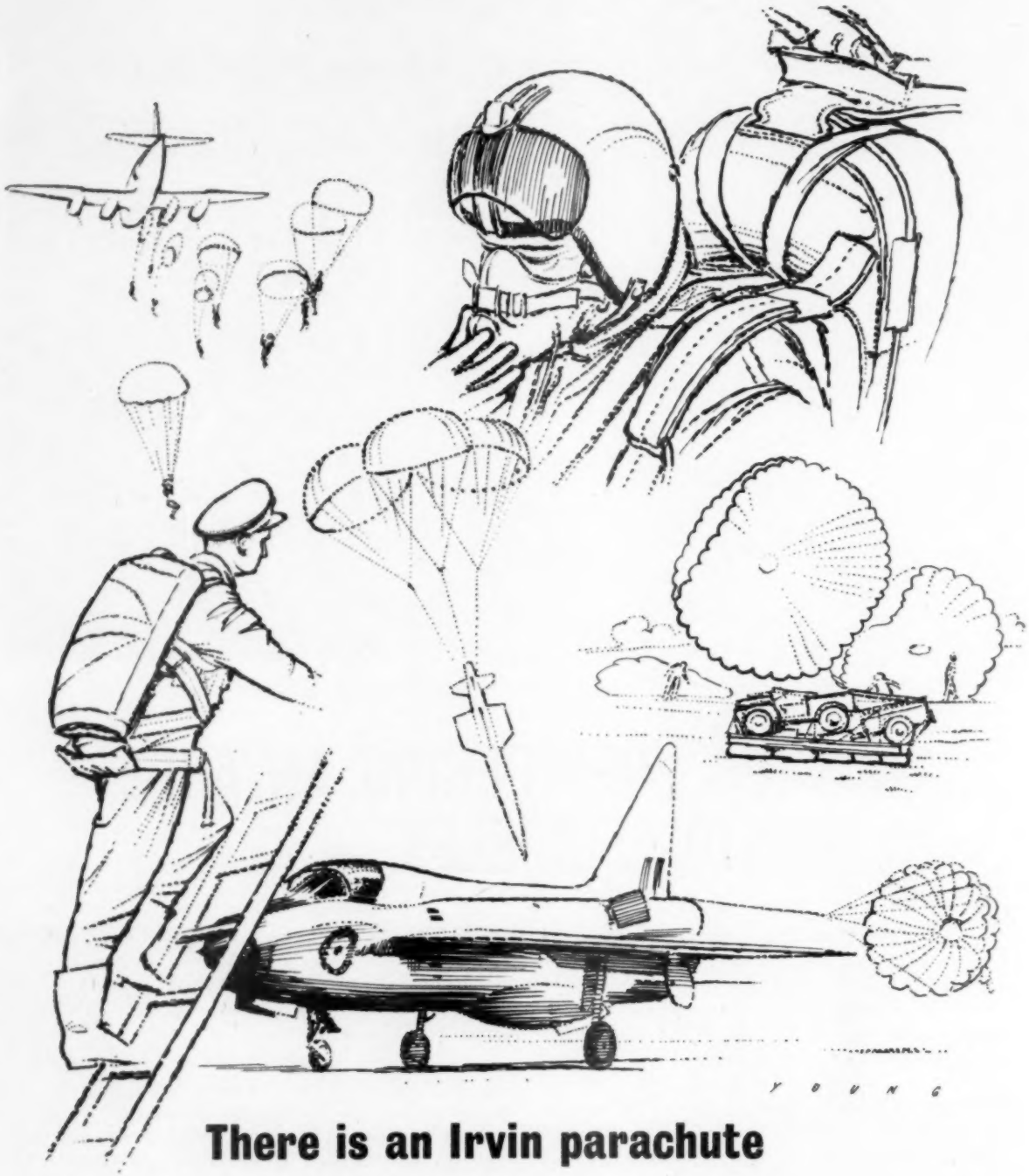
The Bristol Siddeley Orpheus B Or 12, like the earlier versions, achieves its outstanding performance through basic simplicity of design. Producing 6,810 lb thrust dry (8,170 lb thrust with simplified reheat), for a weight of 1,110 lb, the B Or 12 has a very high thrust/weight ratio of over 6:1. This is combined with a good specific fuel consumption (0.933 lb/lb/hr at maximum continuous rpm, sea-level static conditions), very compact dimensions (81.4 in from intake flange to exhaust flange; 32.4 in diameter), and minimum servicing requirements.

Omnipresent Orpheus

The Orpheus family has a far wider range of applications than any other aero-engine in its class. The design has been proved by a remarkable record of trouble-free operation and various Orpheus versions power aircraft ranging from trainers and executive transports to research aircraft and lightweight strike fighters. The last category includes the Fiat G 91, NATO's standard strike fighter, powered by the Orpheus 803 (*shown above*).

The Orpheus is in production in India and Italy as well as Great Britain, and will shortly be built in Germany.

BRISTOL SIDDELEY ENGINES LIMITED



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Air Marshal Sir Robert Saundby

Britain's Air Defence Policy

THE policy of the British Government, reaffirmed in the latest White Paper "Report on Defence, 1960" (Cmd. 952) is—in co-operation with our Allies—to prevent war. For this we still rely mainly on the nuclear deterrent, but because of the Communist military threat, ready at all times to take advantage of weakness anywhere in the defences of the Free World, conventionally armed forces are a necessary complement to nuclear power.

Since 1948 the nuclear power of the West has not only kept the peace in Europe, but has prevented any further encroachment by the Communist bloc. There does not seem to be any reason, provided that the nuclear deterrent is fully maintained, why this balance should not be held until the U.S.S.R. becomes sufficiently liberalized to make possible a reasonable political settlement.

At present the main responsibility for delivering the nuclear weapons rests on the American Strategic Air Command and the British Bomber Command. The V-bomber force is being strengthened by re-equipment with the Mark II Vulcans and Victors, which have better take-off performances and can fly farther and higher than their predecessors. These aircraft can also carry Blue Steel which is an air-launched flying bomb. This will enable the bombers to deliver their nuclear weapons by releasing them at a considerable distance from the target, and thus avoid a deep penetration of defended zones. The Government is apparently satisfied that this capacity will enable the V-bomber force to fulfil its planned tasks effectively for the next five or six years. Supplementing the V-bombers are the American-built Thor missiles, which are deployed in Bomber Command and are now operationally fit.

In addition to the V-bomber force, the naval Scimitar and Sea Vixen—to be joined in the future by the NA39—and the R.A.F. Canberra all can deliver nuclear weapons.

Our defences against enemy bombers have been improved by the surface-to-air guided weapon Bloodhound, and the Lightning supersonic fighter, carrying air-to-air missiles, will, in due course, be in service in Fighter Command. Later, the British liquid-fuelled long-range Blue Streak will, if it proves to be successful, become available as an alternative method of delivering nuclear weapons.

For the deterrent to be effective, it must be perfectly clear to any potential aggressor that it cannot be eliminated by a surprise attack. It must be able to survive such an attack, and indeed must be capable, in any circumstances, of launching a counter-attack in overwhelming strength. This problem of the defence of the deterrent is the crux of the whole matter, for unless we can defend our power of retaliation from destruction in a surprise attack, our deterrent will be ineffective and will fail to prevent a global war.

So long as we have to deal with a surprise attack by hostile long-range bombers the problem is not too difficult. A well-organized defence system—consisting of effective early warning, a high state of readiness on the part of our own bombers so that a substantial proportion of them can take off before an attack could develop, and a powerful defence by means of short-range missiles launched from the ground or from fighter aircraft—would be enough to convince any potential aggressor that a surprise attack could not succeed.

We have an effective early warning system against bombers and, if General de Gaulle can be persuaded to withdraw his objections to a properly integrated European network, it would be more effective still. We keep Bomber Command in a high state of readiness, and a large part of it would be airborne before any attack could develop. Fighter Command

is well organized and highly efficient, and could be relied upon to blunt any attack by hostile bombers.

The situation will be more difficult if, and when, the long-range missile replaces the bomber as the main instrument for delivering hostile nuclear weapons. It will be more difficult to ensure early warning of an attack, and an even higher state of readiness will be needed if our bombers are to be airborne in time to escape the consequences of an attack on our air bases. For the rest, the survival of our deterrent would depend upon concealment, disposal, protection by putting launching sites underground, or by using mobile launching platforms at sea or in the air.

Some people believe that this situation is already upon us. It may be so, but I doubt it. I know that the Russians have given impressive evidence of their missile mastery, and have succeeded in hitting the moon. Also they have claimed to have fired a rocket over a distance of more than 6,500 miles which fell within 1½ miles of the exact wave in the Pacific Ocean that they were aiming at. Nevertheless, I do not believe that the Russians have, at present, a fully operational deployment of long-range missiles on which they could rely to destroy completely the nuclear retaliatory power of Britain and the United States. But even if they have not got it now, they will have it sooner or later, and we must find means of ensuring the survival of our deterrent in the face of such a threat.

The first essential is a ballistic missile early warning system. The object of this device, which is to be built in the East Riding of Yorkshire, is to enable us to put in hand the necessary measures to protect our power of retaliation. It is not, as seems to be supposed by many people, intended to give us a few minutes to say our prayers, nor is it even to give a chance to sound the air raid warning before the blow can fall, though if it can do these things it is all to the good.

Time to Hit Back

If the warning should come when we are still relying on bomber aircraft for the counter-offensive, the difficulties are not insurmountable. Even if only four minutes' warning are given—which is the minimum period in the most adverse possible combination of circumstances—it would still give time to get a fair proportion of our bombers into the air.

More serious difficulties arise if we should rely solely on missiles for our retaliatory power. Our bomber aircraft can be sent off, fully armed with nuclear weapons, and if the alarm should prove to be false, they can be recalled and no harm will have been done. But missiles, once launched, cannot be recalled They can only be destroyed in the air, and it does not need much imagination to see how easily our stock of missiles could be reduced or even eliminated by skilful use of feints or methods of radar deception. If, on the other hand, our missiles are on fixed sites and we should delay launching them until the reality of the attack was established beyond doubt, then we might risk the destruction of our deterrent.

It has been obvious for some time that the policy, put forward by Mr. Duncan Sandys when Minister of Defence, of regarding the V-bombers as the last of their line and relying exclusively on Blue Streak or some similar long-range missile, was open to grave objections. It was always more than probable that it would involve us in the difficulties described above, and this year's White Paper shows a departure from that policy. The most important modification of the Sandys doctrine which it discloses is one which every student of warfare will welcome.

As the White Paper says, there are two main ways in which we can increase the mobility—and thus the security—of our retaliatory power. We can base it on or under the sea, or launch it from the air. The most obvious, and the cheapest, way of taking it to sea would be to launch it from aircraft carriers. But an aggressor would take care to locate the position of our aircraft carriers before starting his surprise attack, and carriers—once their position is known—are very vulnerable to nuclear attack or to attack by guided or homing air-borne or underwater missiles.

The nuclear-powered submarine, however, would seem to have considerable advantages as a missile launching base. It has a great radius of action, has good sea-keeping qualities and, although relatively slow, has more genuine mobility than a surface vessel, as it can pass under the Arctic ice-cap and penetrate into seas denied to the surface ship. In its present stage of development it suffers from two serious disabilities. It is necessary for it to fix its position with great accuracy at the moment of launching and methods of enabling it to do so, especially when submerged, will need to be developed. Secondly, it is absolutely necessary that the Government should be able to pass orders to it at any moment of the day or night. At present this is not possible when it is submerged, and long-distance radio communications are vulnerable to jamming or other forms of interference. These drawbacks must be overcome if submarines are to be relied on to launch a part of our nuclear capacity.

The long-range bomber, used as a missile launcher, also suffers at present from two disabilities, though they are of a less serious nature. As long as the bomber must use long concrete runways, it is tied to large and expensive air bases, which must be limited in number and which cannot be concealed. Although a fair number of the bombers can be airborne before a missile attack could develop, they would be much safer if they had vertical take-off and landing characteristics and could be dispersed among a number of easily concealed sites. Secondly, surface-to-air guided missiles may before long reach a stage of development which will make it impossible for V-bombers to penetrate the defences. To overcome this we have at present the Blue Steel flying bomb, and for the future the possibility of a ballistic missile of considerable range, with a nuclear warhead, which can be launched from an aircraft. The Americans are already developing such a weapon, known as Skybolt.

In order to possess an effective system of air-launched ballistic missiles, we must design and produce a successor to the V-bombers. Ideally this should be a manned supersonic aircraft, capable of vertical take-off and landing, and of carrying a weapon of the Skybolt type. There is, however, a suggestion that it might also be used as a long-range air transport. No doubt, if this could be arranged, the Air Ministry would find it easier to get the money to build them.

In addition, in order to free the long-range ballistic missile from its fixed site, there is an imperative need to develop solid fuel rockets which can be serviced at, and launched from, small easily concealed sites.

These alternatives pose problems of very real difficulty for this country. If we had the resources of the United States we could afford to proceed with all three at once, and select the most suitable methods as they emerged as a result of trial and error. Since we cannot afford to do this, we must either try to pick the winner and gamble on it, or we must wait until American development has revealed pretty clearly which is going to give the best results.

If we have to gamble on picking the winner, the most promising course of action would be to develop the long-range VTOL bomber-transport, armed with a weapon of the Skybolt type.

In the Defence Debate on Feb. 29 Mr. Watkinson explained that, although the defence budget is up this year by more than £100 million, the cost of preserving peace with honour does not represent a disproportionate part of the gross national product. It will be, for 1960-61, about 7.5%, which compares with 8.9% in 1956 and 10.3% in 1954. In simple cash terms, it costs us about 15s. per head per week. This is considerably less than the National Insurance contributions for a normally employed man, which is now 18s. 2d.

The cost of the nuclear deterrent is about 10% of our total defence budget. This figure makes nonsense of the criticism, constantly heard, that we are putting the great majority of our effort into the deterrent and neglecting our conventionally armed forces. In fact, if we gave up the nuclear deterrent we should need, in order to achieve a similar degree of security, an increase in our conventional forces far greater than could be paid for with the 10% saved. We should have to treble or quadruple their strength. Quite apart from the immense cost, the limitations of our manpower make such an expansion out of the question. There is nowadays literally no other choice for us but to rely on the nuclear deterrent to prevent global war, or to be completely powerless to avert it.

The Royal Air Force is this year again the most expensive of the three Services. It will receive a total of £529 million, against £397 million for the Navy and £487 million for the Army. This is as it should be, and our defence is all the sounder for it.

Urgency Unrecognized

In conclusion, the policy set out in the White Paper is more realistic than that of some of its predecessors. Its chief failing, perhaps, is that it does not recognize clearly the urgency of the situation. It may well be later than we think, and we may not have all the time in the world to thrash out and decide on our future policy. In the Defence Debate, Mr. Watkinson said "In the means of delivery of nuclear weapons we are now, and will be for the next few years, as mobile and as well equipped as we or our Allies would wish us to be, and capable, as I have said, of a terrifying retaliation. For the longer-term future we are well placed to pick the best means, or combination of means, to maintain our contribution as long as it is necessary."

I hope that this is true, but in this world of rapid scientific and technical progress it may be rash to assume that we are so well placed. The development of a bomber-transport to succeed the V-bombers, for instance, would take eight years at least, and even if begun now it might well not be in service before 1970.

It is fatally easy to fall behind, especially in the air, and not to realize this until it is too late.

Military Aircraft . . . .

The Future of Manned Aircraft

IN recent years senior R.A.F. officers have taken great pains to emphasize the need for manned aircraft, both strategical and tactical, for many years to come. The logical development of an air-launched ballistic missile (ALBM) beyond the winged air-to-surface missile (ASM) would certainly be favoured by the Service. The future requirements for manned transport, anti-submarine, strike and ground support aircraft have never really been challenged in the same way as those for bombers and interceptors, although some schools of thought have given all types of manned offensive aircraft a very limited operational life.

Apart from the present apparent reappraisal of the future make-up of our deterrent forces, a number of new types are entering, or have recently been introduced, into R.A.F. service both in the United Kingdom and in the overseas theatres of operations. These are two factors which make a study of the estimated operational life of the present and future offensive and support aircraft in the R.A.F. an interesting subject at the present time.

Bomber Command and its deterrent forces has naturally received the majority of attention and, therefore, makes a good starting point. At present operating the first generation of V-bombers—Valiant, Vulcan and Victor—capable of delivering a free-falling nuclear weapon, the Command is expected to receive the first of the developed or second-generation medium bombers this year. Working on the delivery programme of the Mark I aircraft, the Vulcan B2 should come along first, with the Victor B2 following in the latter half of 1961.

These two types, which will progressively replace the present V-bombers by about 1963, should remain in operational service for the next decade. This period is, however, dependent upon a number of completely separate factors such as the operational effectiveness of the aircraft which is governed by foreign developments in fighter and missile defence.

Expected in service with Bomber Command squadrons within two or three years, Blue Steel will be launched by both the Vulcan B2 and the Victor B2. A relative short-range supersonic-cruise type of ASM, Blue Steel is capable of carrying a thermonuclear warhead and is guided by inertial navigation. It will later be replaced by more advanced types of ASMs with greater range and variable trajectory and improved methods of navigation.

Expected in squadron service later this year, the Vulcan B2 is capable of carrying Blue Steel and other more advanced types of air-to-surface missiles.

The operational life of such a missile is obviously limited and over the years it will become less capable of penetrating enemy defences. For this reason, the adoption of the U.S. Skybolt ASBM as a deterrent weapon is being considered for use by the V-bomber force. A relatively small ballistic missile, it is being developed for the U.S.A.F. Strategic Air Command.

Reports state that it is designed for a ballistic range of up to 1,000 miles after being drop-launched from an aircraft flying above or below Mach 1. Powered by a solid-propellent rocket motor which fires immediately it has been launched, the Skybolt is guided by inertial navigation.

The introduction of Skybolt, or any other ASBM, would not

(*Continued on page 374*)

Now undergoing service trials at R.A.F. Coltishall, the first Lightning F.1s should join Fighter Command squadrons in the third quarter of this year.

Front-line Carrier

H.M.S. "Bulwark" (Capt. R. D. Franks, R.N.) is the latest addition to the Fleet and now on her way to the Far East. She is designed to carry one Royal Marine Commando — equivalent to an infantry battalion—with a complement of helicopters, landing craft, and vehicles to enable the Commando to land across beaches and operate well inland. "Bulwark" will normally be deployed east of Suez.

Photographs copyright "The Aeroplane and Astronautics"

Left, Capt. R. D. F
B. M. Tobey, C.O. of
striking formation
"Bulwark"; below,

ranks, R.N. (right) and Lieut. Cdr.
No. 848 Helicopter Sqn. Top left, a
of 16 helicopters from H.M.S.
they are landed-on in sections of five.

A Gnome-powered Whirlwind lifting a lightweight vehicle. A force of such helicopters would help meet the Army requirement for short range tactical weight lifters.

(*Continued from page 371*)

necessarily extend the use of the V-bombers beyond 1970. For this reason, the idea of another weapon carrier, which could be employed in other rôles, is being considered. Coming into service in the early 1970s, such an aircraft could combine its ballistic missile launching capability with that of, say, tanker or transport.

Another important technique which is extending the effectiveness of the V-bomber is air-to-air refuelling. Valiant B(PR)K.1s are now being released by the later V-bombers for the rôle of tanker, although they may have to be replaced by an aircraft with a better performance in years to come.

Home and Overseas Defence

The Central Fighter Establishment is now undertaking the Service trials of the first of Fighter Command's Lightning F.1s which should join the squadrons in the third quarter of this year. This first mark of Lightning is intended to replace some of the Command's Hunter F.6s and the more experienced day-fighter pilots will be the first to convert to the new interceptor. Its weapons system includes two Firestreak AAMs, Aden guns and Airpass radar.

In the all-weather field various marks of Javelin are in squadron service in the United Kingdom and overseas. FAW.7s are the latest to join Fighter Command, although FAW.8s and 9s are expected this year. These three marks of Javelin are all capable of carrying Firestreak AAMs; the FAW.9 is the reheat version of the FAW.7, but the FAW.8 is the most advanced of the trio.

Depending upon the final size of the U.K. interceptor force, a later mark of Lightning will replace all, or the majority, of the remaining Hunters and Javelins in service. Equipped with a more advanced air-to-air weapon this developed Lightning would be capable of intercepting the higher performance bombers.

It has been officially stated that we would not develop another interceptor after the Lightning. But if we are to keep pace with an increasing threat, particularly that of the stand-off bomb, the idea of a long-range defence system which could include another interceptor equipped with improved AI and AAMs of an advanced type must be kept in mind. Such an interceptor would not necessarily be a fighter in the form in which it is known at present, but might possibly be a much larger aircraft capable of carrying 12 or more AAMs.

Military Aircraft . . . .

In the overseas commands some of the types which have been operating for a number of years are now being replaced. In Germany, Swift FR.5s are being superseded by Hunter FR.10s, and the new ground-attack Hunter—the FGA.9—ordered by the R.A.F. last year is now operating in Aden, replacing the Venom FB.4s. In the mid-'60s a new reconnaissance fighter/ground attack aircraft will be required for limited or emergency operations; one obvious choice being the Hawker P.1127. The subject of an M.o.A. design-study contract the P.1127 is a lightweight VTOL fighter capable of low-level operation coupled with a high rate of climb. Such a fighter could be developed for VTOL operation under normal conditions but when overloaded could use STOL or normal take-off techniques.

Changes in the tactical rôle include the assignment of Bomber Command Valiants to the NATO Command to replace Canberra B(I).8s and B.6s. These latter aircraft are being re-deployed in the Middle East to replace Canberra B.2s in service with M.E.A.F. The Valiants, which remain based in the U.K. and equipped with nuclear weapons, are more effective than the Canberra, particularly at night.

The planned supersonic replacement for the Canberra is the TSR-2. A high-performance aircraft for reconnaissance, bomber and ground attack rôles it is due for service in 1965. It is designed to be far more versatile and a better general-purpose aircraft than the Canberra it will replace and it will require runways of reduced length and strength and carry air-to-ground missiles as well as nuclear bombs.

Strategic and Tactical Transports

During the past five years the operational effectiveness of Transport Command has grown rapidly and since 1955 its carrying capacity has increased nearly threefold. By the end of this year, this will have reached a little under 150 million passenger nautical miles per month. In an emergency, this figure could be almost doubled.

One of the Command's primary tasks is to move the R.A.F.; another is the movement of large formations of the Army Strategic Reserve. Both of these tasks include air movement between, and within, theatres of operation and therefore require both long-range strategic and short-range tactical transports—although the individual tasks bring different problems.

The first task, which includes the support of any move by the Bomber Command deterrent force, brings the requirement for long-range transports capable of matching as far as possible the performance of the V-bombers. The second, involving the movement of large formations of troops and their equipment, tends to govern the numbers of such transports. In the tactical rôle, the need is for medium-range freighters and STOL and VTOL aircraft.

The old work-horse of Transport Command, the Hastings, is in the process of being replaced in the strategic rôle by the Britannia C.1, and its large capacity freighter, the Beverley, will be supplemented by the Britannic 3. In addition, there is the Command's high-speed element comprising 10 Comet 2s of No. 216 Squadron.

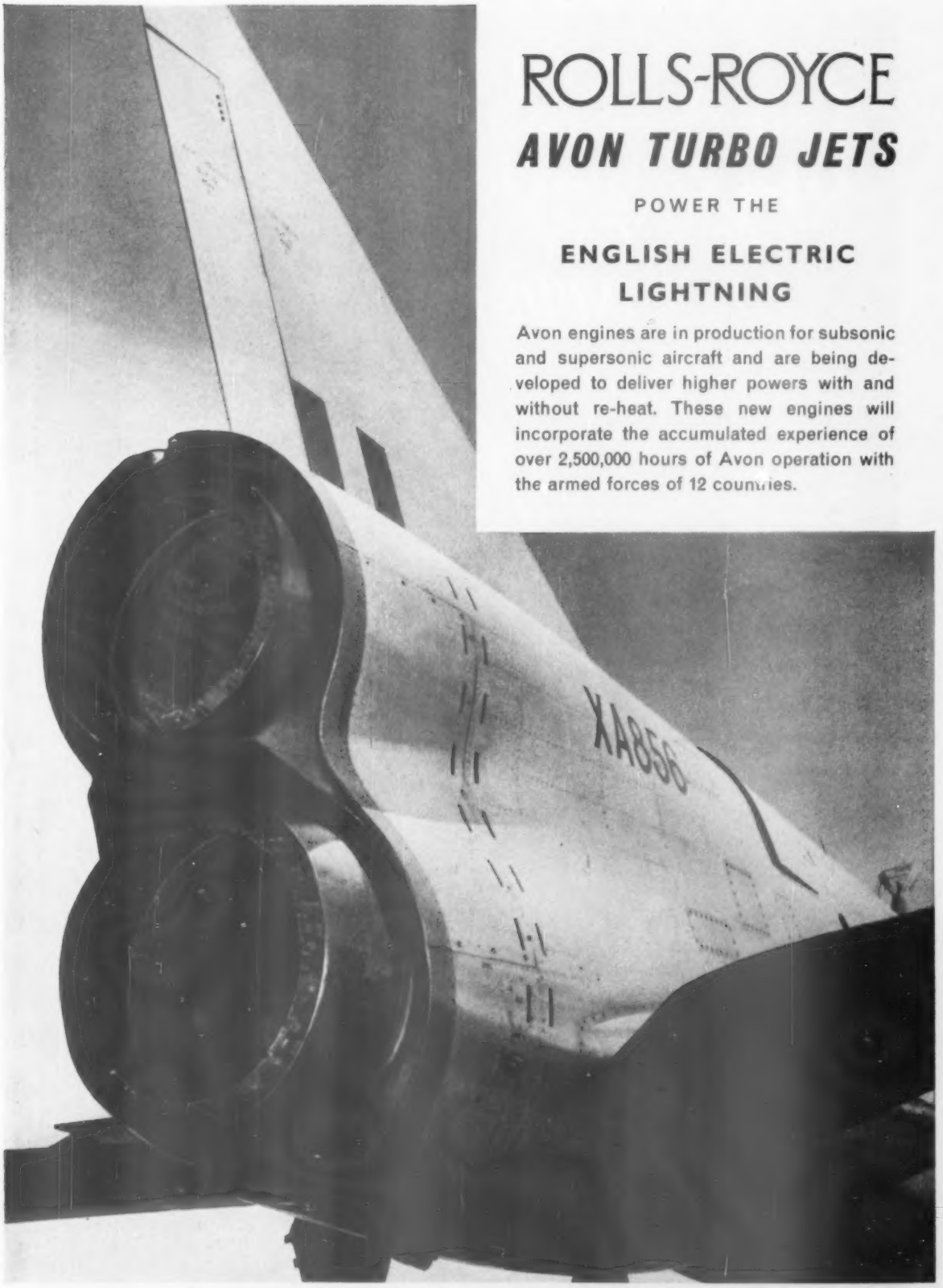
When complete the Britannia force will consist of 20 aircraft and remain in service until the early 1970s. The Britannics are expected to reach the Service in 1964.

To maintain the Command's high-speed element when the Comet 2s fade out two possible solutions are available. One is to order a new jet transport, such as the Vickers VC10 which is due to make its first flight next year, and the second is to buy Comet 4s and so perpetuate a type with which the Service is already familiar. If the latter is decided upon, Comet 4s could be introduced in, say, 1961-62 and so extend the life of the force until the mid '60s, when a military version of a new jet transport could be expected in service.

The combination of such a transport and Britannias would provide a good strategic transport force for some years and by 1975 a supersonic transport could be ready.

In the tactical rôle the combined Hastings/Beverley force is expected to remain in operation until the late '60s. The Armstrong Whitworth 660 is expected in service in 1961. This will cover the period up to about 1975 when a new type of transport, such as a STOL/VTOL aircraft, will be required for Army close support work. To meet the Army's immediate requirement for short-range tactical weight-lifters the R.A.F. is turning to a turbine-powered helicopter force.

From this survey it can be seen that so far as the R.A.F. is concerned both manned offensive and support aircraft will be in service for at least the next 15 years. It is, in fact, difficult to draw a date line when any particular type will no longer be required.—P.R.R.



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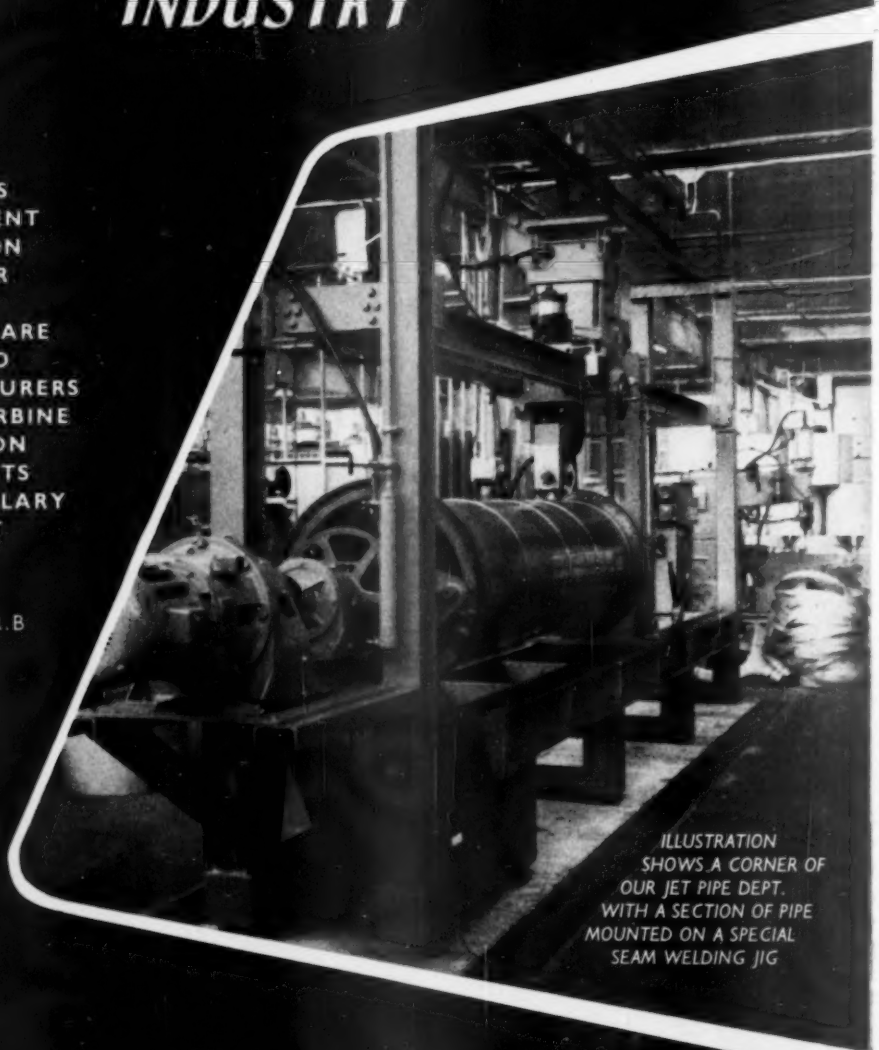

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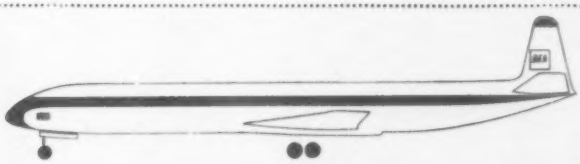

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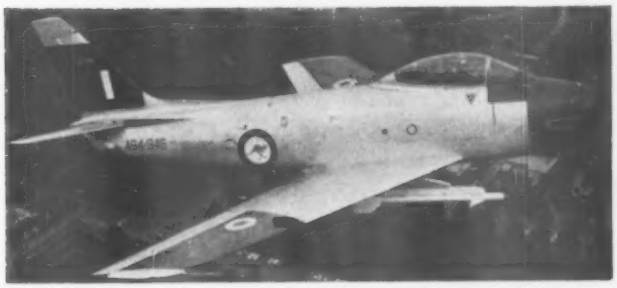
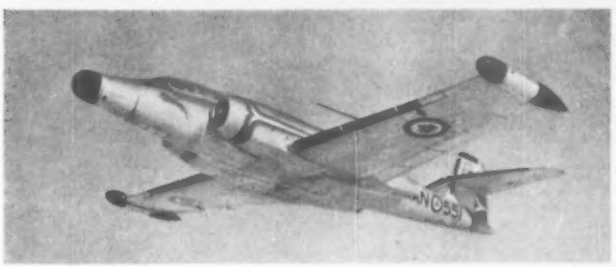


AVON-SABRE **Australia**

Most formidable day-fighter variant of the F-86 is the Avon-Sabre Mk. 32 of the R.A.A.F. (photo.). Built in Australia by the Commonwealth Aircraft Corporation, it has an Avon 26 turbojet and an armament of two Sidewinder infra-red homing missiles and two 30-mm. Aden guns. Many hundreds of other Sabres still in service include the Canadair-developed Sabre 6, flown by the R.C.A.F., S.A.A.F. and NATO air forces; Fiat-built F-86K all-weather interceptors, supplied to the Italian, French, Federal German, Norwegian and Netherlands air forces; Mitsubishi-built F-86F fighters for the Japanese Air Self-Defence Force; and F-86L all-weather interceptors, modified from F-86Ds by North American for NORAD.



AVRO AIRCRAFT CF-100 **Canada**

CF-100 interceptors, produced in Canada by Avro Aircraft, form a major component of NATO's all-weather fighter defences in Europe. Four squadrons of CF-100 Mk. 4Bs are manned by the R.C.A.F., and a total of 53 Mk. 5s, with additional wing and tailplane area for improved performance at height, have been supplied to the Belgian Air Force.

Other Mk. 5s (photo.) equip R.C.A.F. home defence squadrons in Canada. All are two-seaters, with a Hughes MG-2 fire-control system and an armament of 104 x 2.75-in. air-to-air rockets in wingtip pods. The Mk. 4 can also carry a ventral pack of eight 0.5-in. machine-guns.

CANADAIR ARGUS **Canada**

Despite extensive modifications to suit it for a maritime reconnaissance rôle, the Canadair Argus still bears a family likeness to the Britannia transport from which it was evolved. Even the basic fuselage structure is retained; but the interior is unpressurized, with an observation and bombing station in the nose, bomb-bays forward and aft of the wing, and 21 radio and radar systems. The latter include an under-nose search scanner, MAD "tail-sting" and the specially developed ANTAC (air navigation and tactical air control) installation. The latest types of anti-submarine weapon can be carried. Canadair built 13 Argus 1s for the R.C.A.F. and is now working on 20 Argus 2s (photo.) with smaller chin radome and other refinements.

BREGUET ALIZE **France**

Twelve years of development, beginning with the two-seat Br. 960 Vultur strike aircraft with mixed jet and turboprop power, have made the Breguet Br. 1050 Alizé an outstanding carrier-based anti-submarine aircraft. It is a three-seater, with a 2,110 e.h.p. Dart 21 turboprop, and with a large retractable "dustbin" radome in the rear fuselage in place of the original turbojet. A torpedo or three 350-lb. depth charges can be carried in the internal weapons-bay, and there are racks under the wings for two more depth charges and either six 5-in. rockets or two S.S.11M air-to-surface missiles. Sonobuoys are carried in the front of the undercarriage wheel housings. Present production is for the French and Indian Navies.

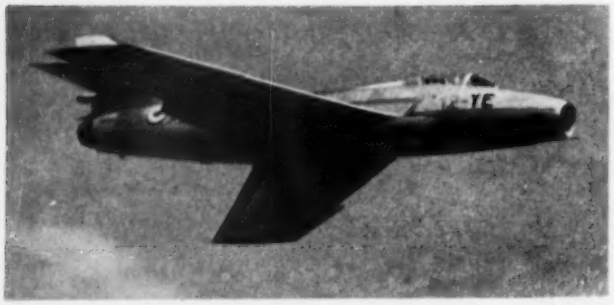
BREGUET ATLANTIC **France**

Chosen from a total of 25 different design tenders as a standardized replacement for the Lockheed Neptune maritime reconnaissance aircraft in NATO air forces, the Breguet Br.1150 Atlantic is an international project. Its centre-wing and engine nacelles will be built by Fokker in the Netherlands, the rear fuselage and tail by Dornier in Germany, fuselage components by Avions Fairey, SABCA and FN in Belgium, the outer wings and undercarriage in France by Sud-Aviation and Hispano respectively, and the main fuselage in France by Breguet, who will also be responsible for final assembly. The Tyne turboprops will be supplied from Britain, and most of the radar equipment from America. A prototype is expected to fly next year.

DASSAULT MYSTERE **France**

Of the 421 Dassault Mystère IVA's produced, 110 have been exported to India and 60 to the Israeli Air Force, which used them in action against Egyptian MiGs during the 1956 Sinai campaign. The remainder equip French Air Force units and were paid for largely by U.S. offshore procurement funds. Standard armament comprises two 30-mm. guns and a fuselage pack of 55 air-to-air rockets. Further rocket packets, or bombs, napalm containers or fuel tanks can be carried on four underwing attachments. The first 50 production machines had 6,280-lb. s.t. Hispano-Suiza Tay turbojets; all subsequent Mystère IVA's have the greatly-improved Verdon 350.

Military Aircraft . . . .

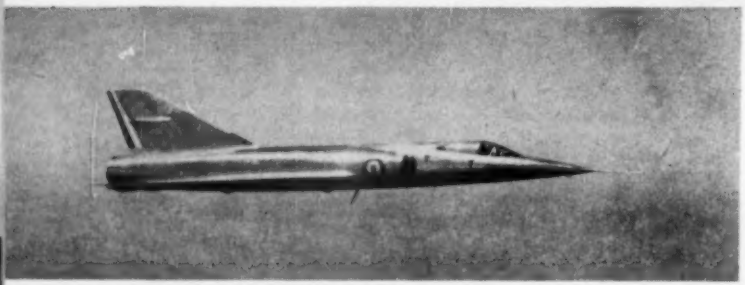


DASSAULT ETENDARD **France**

Dassault designed the original versions of the Etendard to meet NATO and French Air Force requirements in the strike fighter category, with comparatively low-powered turbojets. At the same time, they produced a private-venture version with an Atar engine, which was so outstanding that the French Navy ordered a pre-series, with suitable modifications, for potential operation from its new carriers, the "Clemenceau" and "Foch." These aircraft, designated Etendard IVM, are now flying with 9,700-lb.s.t. Atar 8 turbojet, naval equipment and armament of two 30-mm. guns, plus underwing bombs, rockets or missiles. One (the IVM-03) is fitted experimentally with an Avon 150 and blown flaps, in which form it can operate from light fleet carriers.

DASSAULT MIRAGE III **France**

In quantity production as the standard next-generation single-seat interceptor and strike fighter of the French Air Force, the Dassault Mirage III is in the Mach 2+ category. Despite its comparatively small size, it has a rocket-engine to supplement its afterburning turbojet for take-off and combat, an advanced Cyrano fire-control radar system, and an armament of two 30-mm. cannon, with underwing racks for air-to-surface missiles, Sidewinder air-to-air missiles, bombs or combined fuel tank/rocket packs. Its limited range can be supplemented with underwing tanks. One hundred have been ordered and plans made for a total of 470 by 1965, including 30 two-seat trainer/combat versions designated Mirage III-B.

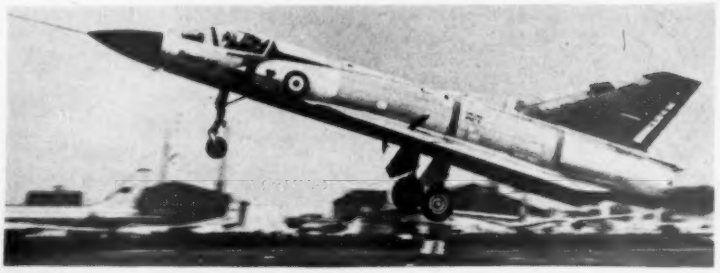


SUD-AVIATION VAUTOUR **France**

Three versions of the twin-jet Vautour are in service with the French Air Force, all similar in basic design and each powered by two Atar 101E-3 turbojets. The 30 Mk. II-As are single-seat ground-attack aircraft with four 30-mm. guns in the fuselage nose, up to 240 rockets or 10 bombs internally and a variety of underwing stores. The 40 Vautour II-B two-seat bombers have a "glass" nose for the bomb-aimer instead of the fixed guns. Most numerous are the 70 Vautour II-N (photo) two-seat all-weather fighters with similar armament to the II-A, plus Matra 5103 air-to-air missiles and automatic search and tracking fire-control radar. A few Vautours have been supplied to Israel.

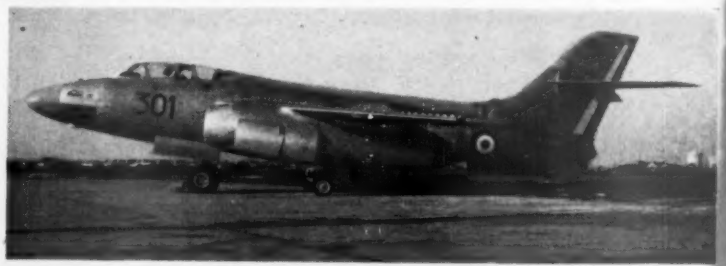
DASSAULT SUPER MYSTERE **France**

The Super Mystère B-2, of which a total of 180 were built, is a progressive development of the Mystère family with the much-more-powerful afterburning Atar 101G turbojet. To take advantage of the extra thrust, wing sweep is increased from 38° to 45° and the aerofoil is thinner than the IVA's 7.5% section. As a result, the Super Mystère offers supersonic performance in level flight at altitude. Like its predecessor it is designed for a mixed armament of two 30-mm. guns and a fuselage pack of 35 air-to-air rockets, supplemented by a wide variety of underwing stores.



DASSAULT MIRAGE IV **France**

Now that France has exploded successfully her first atomic bomb greater interest attaches to the Mirage IV, which is the aircraft designed to carry the bomb. The prototype is a fairly straightforward scale-up of the Mirage III, with tandem seats for a crew of two and two Atar 9 afterburning turbojets. In this form it has exceeded Mach 2, and has flown continuously at Mach 1.9 for about 20 minutes. The 10 pre-production Mirage IVs will have Atar 9Js, and 40 production models are to be delivered in 1964 and 1965. By utilizing flight refuelling, the Mirage IV would be able to attack targets over a radius of about 1,000 miles, cruising at high supersonic speeds above 40,000 ft. on the outward journey, and returning at Mach 0.9.



FIAT G 91 **Italy**

One of the best practical results of NATO joint planning to date, the Fiat G 91 was chosen from 10 designs for production as a standard tactical fighter. The basic version is a single-seat strike fighter, with a 5,000-lb.s.t. Bristol Siddeley Orpheus 803 turbojet and armament of four 0.5-in. machine-guns or two 30-mm. cannon, plus underwing bombs, rockets or missiles. Also in production by Fiat are the G 91R reconnaissance-fighter, with both guns and cameras in a lengthened nose, and the tandem two-seat G 91T trainer. Air Forces to use the G 91 include those of Italy (50 ordered), Germany (70), Greece (25) and Turkey (25); in addition, 232 G 91s will be built in Germany for the Luftwaffe.

(*Continued on page 377*)

Plying through jungle and junks

The river Mekong is the only practical route through the dense undergrowth of Viet-Nam and up-country to the interior of Cambodia. Shell uses the river to supply the airport at Pochentong. But, unfortunately, everybody else uses the river as well. Sampans, houseboats, lighters, barges and the never ending array of junks. Hundreds upon hundreds of them.

The 940-ton Shell tanker 'Angkor' regularly threads her way through this floating jungle on the 300-mile voyage. During the day it's not so bad. At least you can see the boats or, if they are hidden around the next bend, you are bound to hear the hub-bub and commotion long before you reach them. But at night all is quiet and there's hardly a light to warn the skipper of the haphazardly moored craft. Nor a warning of the fishing stakes and nets that go with them. Navigation needs the utmost skill and experience, also a good deal of patience.

Man-made hazards are not all the skipper must contend with. The surrounding countryside is flat and marshy and the river changes its course with the seasons. A channel today may be sand and coral on the next voyage, or just a collection of small streams zig-zagging through the swamp.

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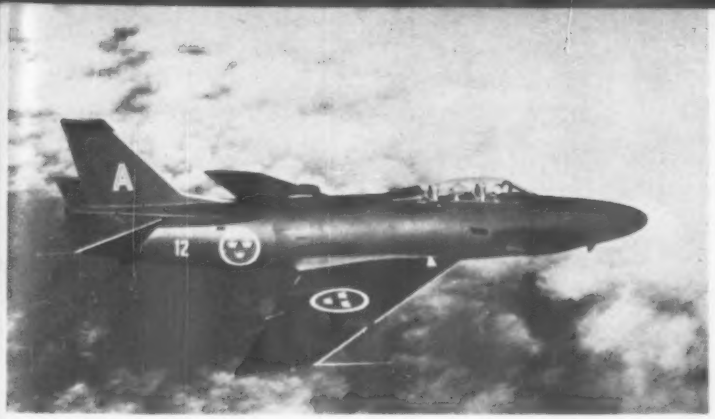
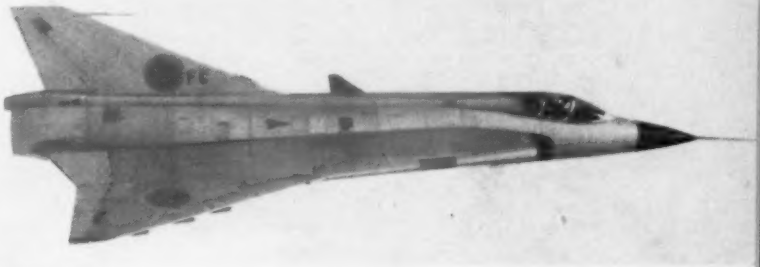


SAAB LANSEN **Sweden**

First version of the dive-supersonic two-seat Saab-32 Lansen to enter service with the Royal Swedish Air Force, in 1955, was the A 32A attack fighter. This has a Swedish-built Avon, known as the Svenska Flygmotor R.M.5, which gives 10,000 lb.s.t. with reheat. Its armament includes four 20-mm. guns and underwing racks for 2,000 lb. of bombs, up to 24 rockets or two Type 304 winged air-to-surface missiles for attacks on targets ashore or at sea. It was followed in production by the J 32B all-weather fighter, with an R.M.6B (200-series Avon), four 30-mm. guns and provision for Sidewinder missiles.

SAAB DRAKEN **Sweden**

Saab's unique "double-delta" wing and advanced versions of the Avon turbojet are combined in the Saab-35 Draken to provide an outstanding fighter in the Mach 2 class. The initial version, already entering service with the Royal Swedish Air Force, is the single-seat J 35A, with 15,200 lb.s.t. Svenska-built R.M.6B engine and an external armament of up to four Sidewinder missiles, rockets or bombs, plus an optional pair of 30-mm. guns in the wings. A tandem two-seat trainer designated the J 35C has already flown. The main future production model is likely to be the single-seat J 35B, with Rolls-Royce RB.146 Avon 300 turbojet (13,220 lb.s.t. dry; reheat thrust unspecified), which will exceed Mach 2 in level flight. It will be available with Ferranti Airpass 2 fire-control radar.



HAWKER SEA HAWK **United Kingdom**

The fact that the Sea Hawk is still in production by Armstrong Whitworth is a tribute to the genius of the Hawker design team under Sir Sydney Camm, for it was that company's first jet-fighter and flew in prototype form 12½ years ago. Designed originally as an interceptor, it is still used in this rôle by the Netherlands Navy (which acquired 22) with Sidewinder missiles supplementing the fixed armament of four 20-mm. guns. Its main current duty, with the Royal Navy and German (68 purchased) and Indian (21 purchased) Navies, is for strike and radar reconnaissance sorties. A typical underwing weapon load includes 16 rockets and two 500 lb. bombs.

AVRO SHACKLETON **United Kingdom**

Standard maritime reconnaissance and air-sea rescue equipment of R.A.F. Coastal Command and the South African Air Force, the Avro Shackleton M.R.3 has also been used for troop transport operations in emergencies. Its development can be traced back to the Lincoln bomber and it is one of the few piston-engined operational aircraft still in front-line service. High speed is not essential for overwater patrol, and the Shackleton is roomy enough to offer a high degree of comfort for the crew of ten during the long operations made possible by the economical Griffon engines and large internal fuel capacity, which is supplemented by wing-tip tanks. A standard ASR lifeboat can be carried under the fuselage.

AVRO VULCAN **United Kingdom**

Deliveries of the Mk. 1 version of the Avro Vulcan to three squadrons of R.A.F. Bomber Command are now complete, and the Service is awaiting the arrival of the more effective Mk. 2 (photo). In place of the four 13,000-lb.s.t. Bristol Siddeley Olympus 104s of the Mk. 1, the later version has four 17,000-lb.s.t. Olympus 201s. Span is increased from 99 ft. to 111 ft., and high-altitude performance is increased considerably. The present internally stowed nuclear weapons will be supplemented soon by the Avro Blue Steel stand-off bomb, and this type of weapon will extend the useful life of the Vulcan through the 'sixties. The bulged tail-cone on the Mk. 2 implies the presence of countermeasures radar.

BLACKBURN N.A.39 **United Kingdom**

One of the boldest of recent British military aircraft concepts, the Blackburn N.A.39 embodies the power, speed, equipment and structural strength necessary to make possible "on the deck" delivery of nuclear weapons at transonic speed. The crew of two is carried in tandem, and there is a large internal bomb-bay. Because of the extensive use of boundary-layer control over the wings and tail surfaces, the N.A.39 has shown itself well suited for operation from small carriers. The entire fuselage tail-cone is made up of sideways-opening air-brakes. These are left wide open, and the wings and nose are folded, to enable the aircraft to use standard carrier deck-lifts.

Military Aircraft . . . .

DE HAVILLAND SEA VIXEN **United Kingdom**

In service with the Royal Navy since July, 1959, the de Havilland Sea Vixen is a formidable two-seat all-weather carrier-based fighter to supersede the Sea Venom. It is supersonic in a shallow dive and carries an extremely heavy armament. Normally this will comprise four under-wing Firestreak air-to-air missiles, plus 28 two-inch rockets in two retractable packs under its nose. No guns are fitted, but the Firestreaks can be replaced by a wide variety of stores, including bombs, rockets or fuel tanks, for the aircraft's secondary role of strike-reconnaissance.

ENGLISH ELECTRIC CANBERRA **United Kingdom**

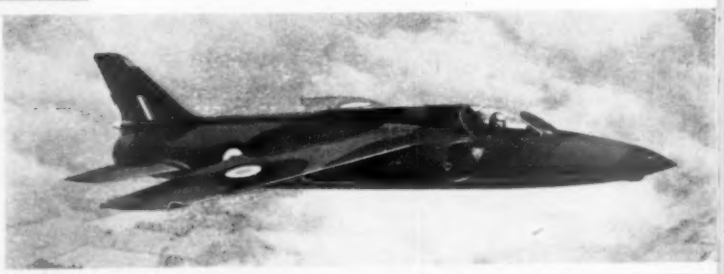
The English Electric Canberra has been in continuous production for some 11 years. All Marks have been powered by two Rolls-Royce Avons, initially of the Avon 101 series, later the 109 (Canberra Mks. 4, 6, 7 and 8) and currently the much more powerful 206 (Mk. 9). Versions now in service include the B.Mk.6 three-seat tactical bomber with nuclear capability, B(I) Mk. 8 intruder bomber (photo) with under-fuselage gun-pack added to internal and underwing bombs, P.R.Mk. 9 high-altitude P.R. aircraft and T.Mk. 4 operational trainer. Other variants are the "radar-nose" T.Mk. 11 all-weather fighter trainer and U.Mk. 10 target drone. Canberras have been supplied to seven overseas air forces and built in Australia and the U.S.A.

ENGLISH ELECTRIC LIGHTNING **United Kingdom**

Due to enter service with the R.A.F. later this year, the English Electric Lightning will give Fighter Command its first level-supersonic interceptor, with an all-round performance and firepower second to none. The initial F.Mk. 1 version has two 17,250-lb.s.t. Avon 200 (R.A.24R) turbojets with reheat; later Marks will have the Rolls-Royce R.B.146 Avon 300. Two fixed 30-mm. guns and two Firestreak infra-red homing missiles form the standard armament, in conjunction with Airpass fire-control radar. The missiles are interchangeable with rocket packs, additional guns or cameras. Also in production is the Lightning T.Mk. 4 side-by-side two-seat trainer.

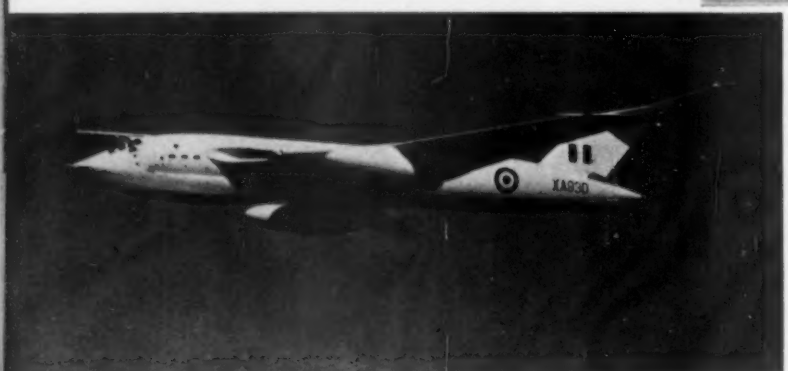
FOLLAND GNAT **United Kingdom**

Although the diminutive Folland Gnat will serve with the Royal Air Force only in its tandem two-seat trainer form, with de-rated 4,230-lb.s.t. Orpheus 100, it is in production in India as a single-seat interceptor with two 30-mm. guns and provision for underwing stores. Finland and Yugoslavia have also had small numbers of Gnat fighters for evaluation, as has our own Ministry of Aviation (photo). The trainer is some 15 per cent. bigger all round, the increased wing area giving more docile low-speed handling characteristics and the longer fuselage providing room for the second cockpit. Performance is high enough to give pupils experience in the transonic speed range.



GLOSTER JAVELIN **United Kingdom**

Fighter Command's standard two-seat all-weather interceptor, the Gloster Javelin is well liked by its crews and well-suited to counter the present manned bomber threat to the U.K. The Mks. 1 to 6 had two Series 100 Sapphire turbojets, each giving 8,300 lb.s.t. A switch was made to 200-series Sapphires on the Mks. 7 and 8, the latter being fitted with reheat (photo). The Mk. 7s are being provided with reheat retrospectively and, with other changes, become Mk. 9s. Standard armament of the Mks. 7-9 comprises two wing-mounted 30-mm. guns, plus four underwing pylons for interchangeable Firestreak missiles or packs of 37 two-inch rockets.



HANDLEY PAGE VICTOR **United Kingdom**

Bomber Command's planned equipment of four squadrons with Handley Page Victor B.Mk. 1 (photo) aircraft was scheduled for completion early this year. The first Victor B.Mk. 2 squadron will form in 1961. As in the case of the Vulcan, considerable development of the basic design has proved possible, and the Mk. 2 will have four 17,250-lb.s.t. Rolls-Royce Conways instead of the 11,000-lb.s.t. 200-series Sapphires of the Mk. 1. Span is increased by 10 ft. to 120 ft., and primary armament will be the Blue Steel stand-off bomb. Both the Vulcan and Victor can be flight refuelled and can utilise two D.H. Spectre assisted take-off rocket packs. A P.R. version of the Victor is in service.

SURVIVAL, FOR US AS FOR THE CHAMELEON, DEMANDS VERSATILITY

You cannot take a chameleon by surprise. It can always adapt itself to the prevailing conditions. It owes its survival to this adaptability. The same principle applies in modern warfare. A defence system which is flexible in application is less likely to be defeated than one which is not.

A MISSILE THAT DOES TWO JOBS

Thunderbird can be used in two ways. It can be used efficiently in a static role operating from a preselected site for as long as it is tactically required there, and it needs no concreting-in. It can also be rapidly redeployed to meet some new threat should the need arise – and attack seldom hits us where we are expecting it.

Thunderbird can be moved easily and quickly – on wheels or by air. Now in service with the Army and designed round standard service vehicles it can be redeployed and in action where most needed within hours. Its inherent mobility and air transportability provides that flexibility which is of ever increasing importance in present and future air defence.

NEW DEVELOPMENTS

And evolution still goes on. Already the successor to Thunderbird has been under development for some considerable time. Using the latest techniques and retaining its full mobility, the new version will provide, among other things, increased low-level capability and longer range.

The Chameleon has survived because its versatile defence gives protection anywhere. Our own survival may equally depend on similar versatility.

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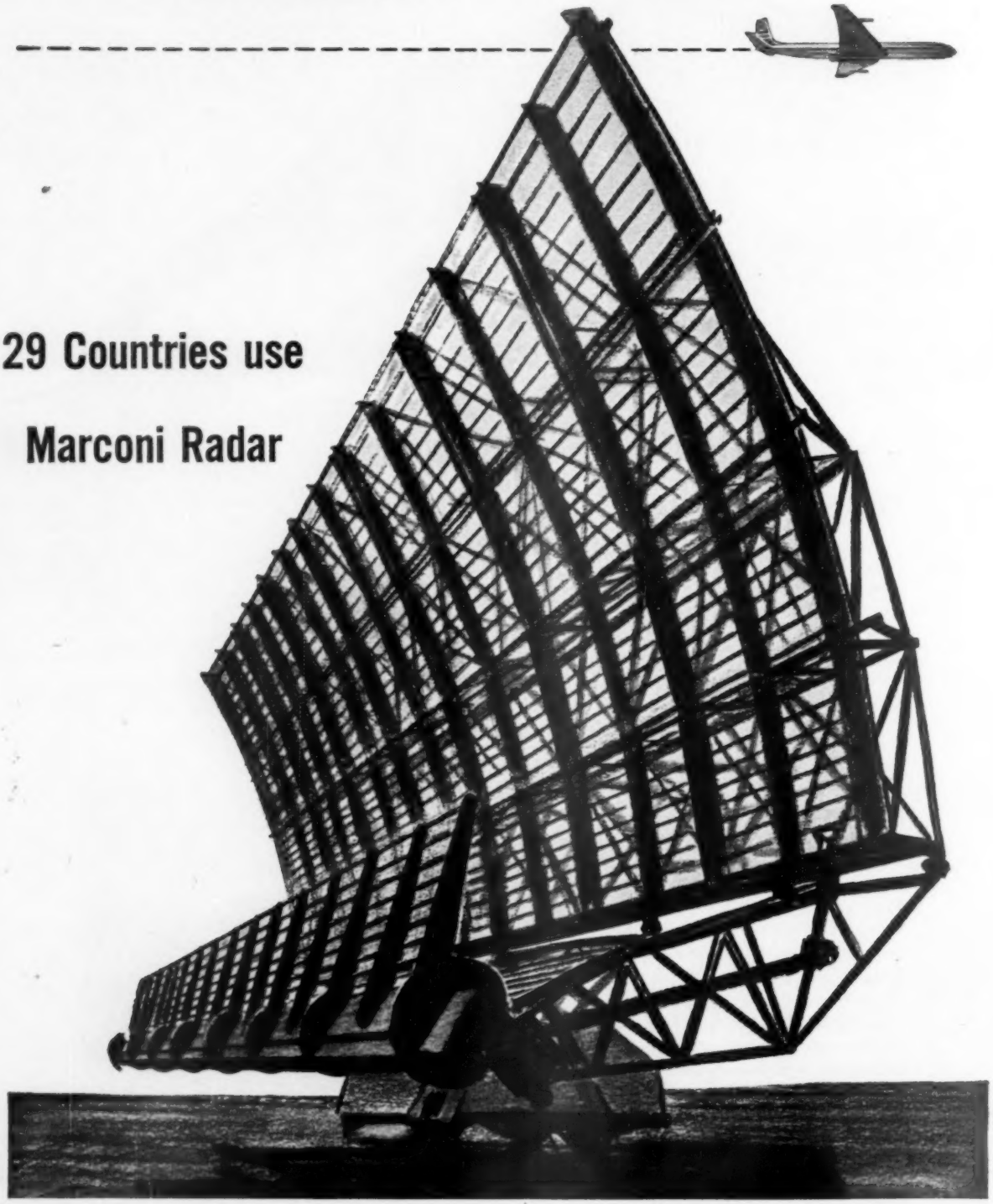
Marconi in Radar



29 Countries use Marconi Radar

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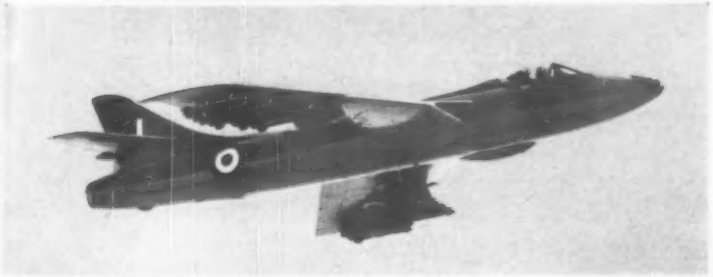
Military Aircraft . . . .



HAWKER HUNTER — United Kingdom

No British military aeroplane has earned as much money from export orders as the Hawker Hunter. This alone indicates the all-round excellence of the aircraft that has been the R.A.F.'s standard day interceptor since 1954. As well as the standard F.Mk. 6 (photo.) single-seat fighter, with four 30-mm. Aden guns, the R.A.F. uses the F.G.A. Mk. 9 ground-attack version with underwing stores and the T.Mk. 7 side-by-side two-seat trainer. (Naval counterpart T.Mk. 8). About 450 Hunter Mks. 4 and 6 were built in Holland and Belgium for the air forces of those countries. Export versions of the Mk. 4 include the F.Mk. 50 (120 for Sweden), F.Mk. 51 (30 for Denmark), and F.Mk. 52 (16 for Peru). The F.56 is an F.6 for India (140 ordered) and the F.58 an F.G.A. 9 for Switzerland (100 ordered).

VICKERS-ARMSTRONGS SCIMITAR — United Kingdom

Re-equipment of those Royal Naval squadrons intended to fly the Vickers-Armstrongs, Supermarine, Scimitar F.Mk.1 single-seat carrier-borne fighter/strike aircraft has now been completed. The consequent increase in combat strength of the Fleet Air Arm is considerable. Powered by two 200-series Avons, the Scimitar is supersonic in a dive, has a very high rate of climb and yet offers good deck-flying characteristics because of its use of a "super-circulation" flap-blowing system. The fixed armament of four 30-mm. guns can be supplemented by underwing rockets or bombs, including nuclear weapons for the strike rôle. About 100 Scimitars are believed to have been ordered.

VICKERS-ARMSTRONGS VALIANT — United Kingdom

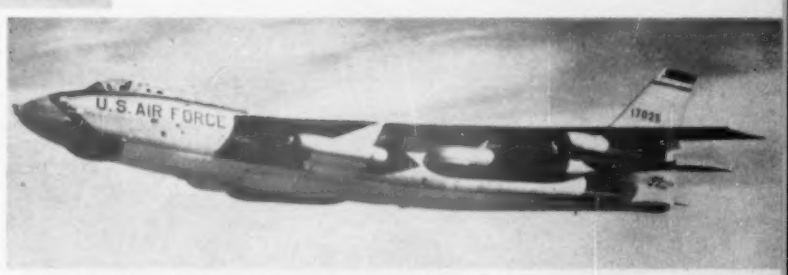
Proof of the growing strength of Bomber Command's main force of Vulcan and Victor bombers is that numbers of Vickers Valiants are to be assigned to replace R.A.F. Canberras committed to the tactical air force in Europe. Others are equipped as flight refuelling tankers for servicing V-bombers and the Javelin and Lightning all-weather interceptors of Fighter Command. Production of the Valiant ended in 1957, after more than 100 had been built. Although somewhat outclassed by the larger Vulcan and Victor, these aircraft are capable of carrying nuclear weapons and have, in fact, been used for early test drops of Britain's atomic and hydrogen bombs and Blue Steel stand-off bombs.

WESTLAND WESSEX — United Kingdom

During this year, the Westland Wessex H.A.S. Mk. 1 will begin to replace the Whirlwind for anti-submarine duties with the Navy. It is the familiar Sikorsky S-58, re-engined with a Napier Gazelle shaft-turbine and built under licence in the U.K. Technically, its introduction will be welcome as the switch to turbine power will enable the Wessex to use the same fuel as other Fleet Air Arm front-line types. Operationally, the changeover will have the greatest significance, as the Wessex can strike as well as hunt submarines in all weathers by day or night, using homing torpedoes and other weapons.

BOEING STRATOJET — U.S.A.

For nine years the Boeing B-47 Stratojet has been a mainstay of the U.S.A.F. Strategic Air Command and many hundreds remain in front-line service, side-by-side with the larger, longer-range B-52s. All are powered by six J47 turbojets, giving a maximum speed of over 600 m.p.h., and the B-47E's nominal range of about 3,200 miles can be extended indefinitely by flight refuelling. A crew of three is carried. Defensive armament consists of a pair of 20-mm. guns in a radar-aimed tail turret, and the 20,000-lb. bomb-load can include nuclear weapons. Variants include the RB-47B and E for reconnaissance, and RB-47K for weather reconnaissance.



BOEING STRATOFORTRESS — U.S.A.

The Boeing B-52 Stratofortress spearheads the nuclear striking power of Strategic Air Command. It carries a crew of six, has four 0.5-in. guns in a radar-directed tail-turret and is notable for its multi-bogie cross-wind landing gear. All versions up to the current B-52G have eight J57 turbojets, paired in underwing pods, and the "G" is the heaviest aeroplane yet put into service, with a loaded weight of 480,000 lb. It is the first version to carry Hound Dog stand-off bombs under its inner wings, and Quail decoy missiles. Following it in production is the B-52H (illustrated) with eight 17,000-lb.s.t. P.W. TF33 turbofan engines.

Military Aircraft . . . .

CHANCE VOUGHT CRUSADER **U.S.A.**

The Chance Vought Crusader single-seat carrier-based fighter became operational with the U.S. Navy in 1957 and more than 500 had been built by this time last year. The initial F8U-1 version (16,000-lb. J57-P-4A turbojet with reheat) is being superseded by the F8U-2 (photo) with more powerful engine and under-fuselage stabilizing fins. Soon to follow is the F8U-2N, with 18,000-lb.s.t. J57-P-20 and limited all-weather capabilities. Standard armament is four 20-mm. guns, two Sidewinder missiles and 32 unguided rockets.

CONVAIR HUSTLER **U.S.A.**

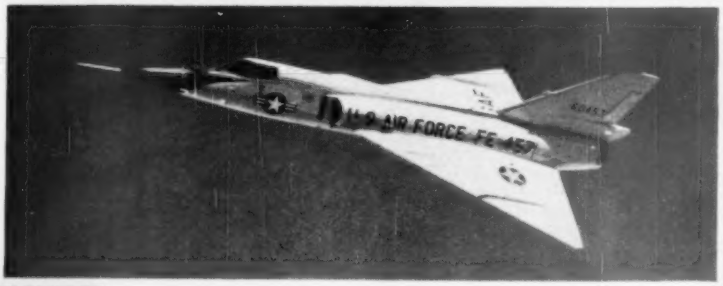
First supersonic bomber in the West, and perhaps the first to enter service anywhere, is Convair's delta-wing B-58A Hustler. Bristling with pods, it carries four J79 turbojets under its conical-cambered wings, and a powered nuclear bomb, or pod for weapons or counter-measures equipment, under its fuselage. The crew of three sit in tandem and will eventually be provided with self-contained emergency escape capsules instead of the usual ejector seats, for survival at speeds up to Mach 2. Present orders are for a total of about 110 aircraft, including the two prototypes, and these are intended to replace the B-47 Stratojets of Strategic Air Command.

CONVAIR DELTA DAGGER **U.S.A.**

One of the major weapons of the joint U.S.-Canadian North American Air Defense Command, the Convair F-102A Delta Dagger first flew in prototype form on October 24, 1953. Intensive wind-tunnel and flight test investigations followed, to provide supersonic performance, and led to the introduction of the now-familiar area-ruled fuselage with "wasp-waist" and bulbous tail. The single-seat F-102A is the standard all-weather interceptor version, with a speed of Mach 1.25 at height; its armament is six Hughes Falcon air-to-air missiles and 24 unguided rockets. The TF-102A is a side-by-side two-seat combat/trainer with similar armament and fire-control radar.

CONVAIR DELTA DART **U.S.A.**

Present holder of the World absolute air speed record, at 1,525.95 m.p.h., is the Convair F-106A Delta Dart. It is a "stage two" development of the F-102A, designed to take advantage of the greatly increased power of the Pratt & Witney J75 turbojet, and is a much-refined design. Most noticeable changes are the shorter engine air intakes, elimination of the rear fuselage blister-fairings of the F-102A and introduction of a square-tip fin. Armament comprises two nuclear-warhead Genie air-to-air rockets and six Super Falcon missiles in a similar type of internal weapons-bay to that of the F-102A. A tandem two-seat combat/trainer variant is designated F-106B.



DOUGLAS SKYWARRIOR **U.S.A.**

Until the appearance of the Vigilante, the Douglas A3D Skywarrior was the largest and most powerful carrier-based aircraft in the World. The XA3D-1 prototype flew on Oct. 28, 1952, with Westinghouse J40 turbojets, but all production aircraft have had J57s. The basic A3D-1 (J57-P-6) and A3D-2 (J57-P-10) are three-seat attack bombers capable of supersonic speed in a dive and with internal stowage for bombs and other stores, including nuclear weapons. Two 20-mm. guns are fitted in a radar-directed tail mounting. Variants are the photographic-reconnaissance A3D-2P with 12 cameras, seven-seat A3D-2Q radar counter-measures aircraft and eight-seat A3D-2T bombardier trainer. Some are equipped as flight refuelling tankers; all can be refuelled in flight.

DOUGLAS SKYHAWK **U.S.A.**

The Douglas A4D Skyhawk was nicknamed "Heinemann's "hot-rod" when it first appeared, because of its small size, comparatively high power and very heavy military load. Under designer Ed Heinemann, Douglas had given the U.S. Navy a combat jet aircraft small enough to use carrier lifts without wing-folding, yet with the ability to carry 5,000 lb. of stores, including nuclear weapons, under its wings and fuselage. Versions produced to date are the A4D-1, the A4D-2 (photo.) with control system refinements, and the all-weather A4D-2N with additional radar in a lengthened nose. All are single-seaters with two 20-mm. guns in the wing-roots. A flight refuelling probe is fitted on the fuselage nose of later production machines, which can also act as tankers.

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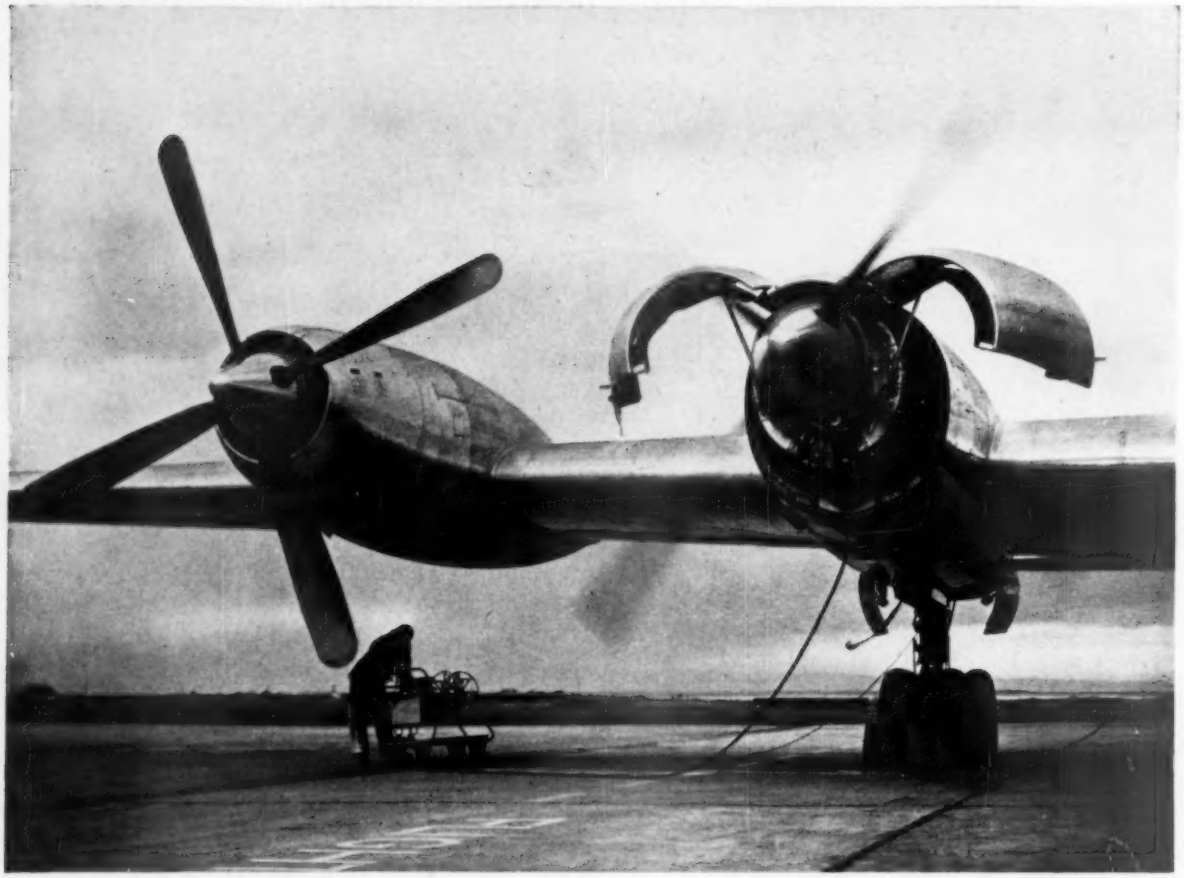

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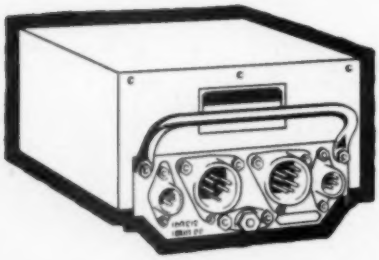

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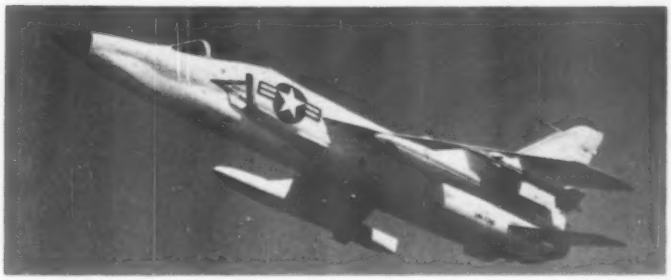
Military Aircraft . . . .

DOUGLAS B-66 **U.S.A.**

Based on the A3D Skywarrior, the Douglas B-66 series is standard tactical bomber and reconnaissance equipment in the U.S.A.F. Major changes include a switch to two Allison J71 turbojets and deletion of wing-folding. Only five RB-66As (J71-A-9) were built, followed by the B-66B Destroyer bomber (photo.), with crew of three, J71-A-11 or -13 turbojets, internal stowage for 10,000 lb. of bombs and armament of twin 20-mm. tail-guns. Production of the RB-66B, with five cameras and photoflash bombs for night photo-reconnaissance, and RB-66C for all-weather electronics reconnaissance totalled 149 aircraft; 55 weather reconnaissance WB-66Ds were also built.

DOUGLAS SKYRAY **U.S.A.**

The early development of the Douglas F4D-1 Skyray was dogged by the misfortunes of the Westinghouse J40 turbojet around which it was designed. The two prototypes flew initially with a 5,000-lb.s.t. Allison J35-A-17, before first the 7,000-lb.s.t. XJ40-WE-6 and then the 11,600-lb.s.t. afterburning XJ40-WE-8 became available. With the latter, one of them set up a World speed record of 752.9 m.p.h., but the J40 was abandoned and production Skyrays have the more powerful J57, which gives them a supersonic performance at height. Altogether 419 were built for the U.S. Navy, with an armament of four 20-mm. guns and attachments for up to 2,000 lb. of stores.



GRUMMAN TIGER **U.S.A.**

Although built in comparatively small numbers, the Grumman F11F-1 Tiger carrier-based fighter has a high performance and handles well enough to be the mount of the U.S. Navy's famous "Blue Angels" aerobatic team. The prototype first flew on July 30, 1954, and was followed by six pre-production machines before the type went into production in both single-seat fighter and F11F-1T tandem two-seat trainer versions. Two F11F-1s were converted to F11F-1F Super Tiger standard, with 15,000-lb.s.t. General Electric J79-GE-3A turbojet and speed approaching Mach 2; but this version did not go into service. Armament comprises four 20-mm. guns and two or four Sidewinder missiles.

GRUMMAN S2F **U.S.A.**

A whole family of naval aircraft has evolved from the Grumman XS2F-1 prototype, which flew on December 4, 1952. First production version was the S2F-1 four-seat anti-submarine aircraft (photo.), with retractable underfuselage radome, MAD "tail-probe," searchlight on the starboard wing, sonobuoys in the rear of the engine nacelles, underwing rockets and depth charges, and a bomb-bay for weapons that include the Betty atomic depth charge. The S2F-2 has an extended bomb-bay to carry larger weapons, and the S2F-3 has increased span and length. Production to date totals about 700, for the U.S. Navy, Italy, Japan and the Netherlands; and 100 are being built by D.H. Canada for the R.C.N. Off-shoots are the TF-1 Trader trainer/transport and WF-2 Tracer with huge over-fuselage E.W. radar scanner.

LOCKHEED STARFIGHTER **U.S.A.**

The original F-104A and two-seat F-104B (with J79-GE-3A engines) have now been withdrawn from U.S.A.F. Air Defense Command, leaving the Tactical Air Command's F-104C and two-seat F-104D (J79-GE-7) as the principal versions. Mitsubishi will build 180 F-104C-J and 20 F-104D-J for Japan. The multi-rôle F-104G has been adopted by the R.C.A.F. (200 to be built by Canadair) and by several N.A.T.O. Air Forces. Two groups, including German, Dutch and Belgian manufacturers, will supply 574 F-104Gs to the Luftwaffe, about 200 to the Netherlands, about 100 to Belgium and others to Italy. Lockheed will supply 66 F-104G and 30 F-104D to the Luftwaffe and 20 F-104D to the Netherlands.

LOCKHEED NEPTUNE **U.S.A.**

The Lockheed Neptune 7-seat maritime patrol bomber has been in continuous production since 1944. The third P2V-1 set a World distance record of 11,235 miles in 1946 which still stands. It had two 2,300-h.p. Wright R-3350-8 engines. Progressive development has led to the current P2V-7, with 3,500-h.p. R-3350-32Ws and underwing turbojet to improve take-off and combat performance; most P2V-5 and -6 Neptunes have been brought up to -7 standard. They serve with the U.S. Navy, and in the Argentine, Australia, Canada, France and the Netherlands. Radar includes an under-fuselage scanner and MAD tail-probe. An 8,000-lb. internal weapon load is supplemented by 16 rockets under the wings.

Military Aircraft . . . .

LOCKHEED YP3V **U.S.A.**

Intended as a successor to the P2V Neptune, the Lockheed YP3V-1 is an adaptation of the basic Electra airliner design for maritime reconnaissance duties with the U.S. Navy. The original prototype, which flew on August 19, 1958, utilized the third Electra airframe. It has been followed by a genuine operational prototype (illustrated), which will flight test the more powerful Allison turboprops specified for the production P3V-1s for which Lockheed have an initial order. Torpedoes, depth charges and special weapons are carried in a bomb-bay forward of the wing. Search equipment includes a nose scanner and MAD tail-sting.

McDONNELL VOODOO **U.S.A.**

A past holder of the World air speed record, at 1,207.6 m.p.h., the McDonnell F-101 Voodoo was developed from the XF-88 prototype twin-jet long-range penetration fighters of 1948-50. When the requirement for this type of aircraft lapsed, the much-developed F-101A was produced instead as a multi-purpose single-seat fighter, and entered service with U.S.A.F. Tactical Air Command in 1957. Its armament includes four 20-mm. guns, three Falcon missiles on a rotary bomb-door and 12 air-to-air rockets. The two-seat F-101B of Air Defense Command can carry two nuclear-warhead Genie rockets. Other single-seat variants are the F-101C, which is strengthened for low-level attack with nuclear weapons, and the camera-carrying RF-101A.

McDONNELL DEMON **U.S.A.**

The McDonnell F3H Demon single-seat naval fighter is another aircraft which survived a bad start. The prototype flew on August 7, 1951, and the U.S. Navy ordered 150 F3H-1s with Westinghouse J40-WE-22 engines. Changing operational requirements led to a 30% increase in all-up weight at this stage, so the higher-thrust J40-WE-24 was fitted instead. This proved inadequate, and when the J40 was abandoned 29 of the 56 completed F3H-1s were re-engined with Allison J71 turbojets to become F3H-2s. Another 90 were built from scratch. These are in service as the F3H-2N all-weather fighter with four 20-mm. guns and Sidewinder missiles, bombs or rockets, and the F3H-2M day-fighter with guns and four Sparrow III missiles.

McDONNELL PHANTOM **U.S.A.**

Although far from handsome, the McDonnell F4H-1 Phantom II all-weather interceptor has an outstanding performance and is intended to replace the F8U-2 Crusaders and F3H Demons in U.S. Naval service. It is a tandem two-seater, with two J79 turbojets, and is claimed to have the greatest range of any U.S. naval jet-fighter as well as a speed of Mach 2 at height. The 45° swept wings have blown flaps, leading-edge flaps, air-brakes, a sawtooth leading-edge and considerable dihedral on the outer panels. The tailplane has 23° of anhedral. Standard armament is four Sparrow III missiles, but the F4H-1 can carry also nuclear or conventional bombs and missiles or "buddy" refuelling equipment.

MARTIN MARLIN **U.S.A.**

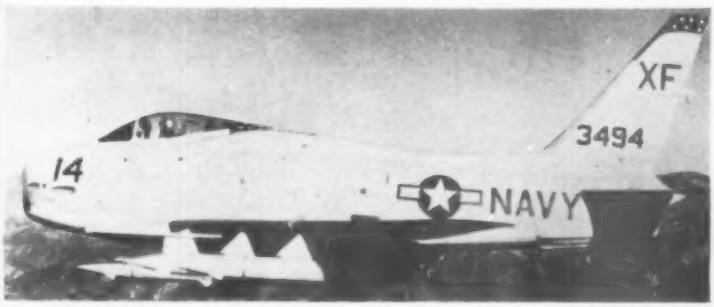
Almost the sole survivor of a long line of maritime patrol flying-boats is the Martin P5M Marlin. It was developed post-war for the U.S. Navy and has been produced in two versions. First was the P5M-1, with 3,250-h.p. Wright R-3350-30WA Turbo Compounds, which entered service in 1951. Eighty are being modified by the fitting of MAD equipment and other improvements, and some serve with the U.S. Coast Guard for ASR duties. The later P5M-2, with more powerful engines, can be identified by its T-tail, which replaced the low-set tail-plane of the P5M-1. It entered U.S. Navy service in 1954 and 10 have been supplied to the French Navy. Marlins carry a crew of seven, weapons in their engine nacelles, and a very powerful radar scanner in their nose.

NORTH AMERICAN VIGILANTE **U.S.A.**

The North American A3J-1 Vigilante is by far the largest aircraft yet built for carrier operations and forms an interesting contrast to the British Blackburn NA.39, which is similarly a two-seat twin-engined naval attack bomber. Key to the difference is that the A3J is intended for high-altitude operation, carrying thermonuclear weapons over a range of several hundred miles at an over-the-target speed of Mach 2. This inevitably produced a large aircraft, with two very powerful engines. The prototype flew on August 31, 1958, and the type is now in production. A unique feature is that its bombs are ejected from the tail, through a tunnel leading from the large weapons-bay.

NORTH AMERICAN SUPER SABRE **U.S.A.**

Production of the North American F-100 Super Sabre ended last October, but this very powerful fighter-bomber is likely to remain in service with the U.S.A.F. and foreign air forces, including those of France, Denmark and Turkey, for many years. The prototype flew on May 25, 1953, and the F-100A was the first fighter capable of level-supersonic flight to enter service. It was a single-seater with a J57-P-7 or -39 turbojet, and was armed with four 20-mm. guns. It was followed by the F-100C with J57-P-21 engine and underwing attachments for bombs and tanks for fighter-bomber duties. The F-100D introduced an advanced auto-pilot and other improvements, and the F-100F is a two-seat development.



NORTH AMERICAN FURY **U.S.A.**

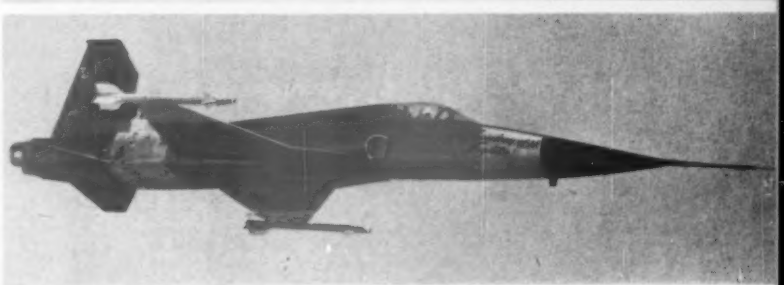
The first XFJ-2 Fury single-seater naval fighter, based on the North American F-86 Sabre, flew on February 19, 1952, and several hundred FJ-2s were built subsequently with a 5,900-lb.s.t. J47-GE-27 turbojet. Then followed the FJ-3, in which the powerplant was changed to a 7,200-lb.s.t. Wright J65-W-2, and later a 7,700-lb. J65-W-16. In 1954 came the much-redesigned FJ-4, with deeper fuselage, thinner wing, mechanically drooped leading-edge, slotted flaps and other changes. All of these versions had four 20-mm. cannon and were basically interceptors. In contrast the final version, the FJ-4B, is an attack fighter, able to carry six Sidewinder air-to-air missiles or five Bullpup stand-off bombs under its wings, in addition to the fixed armament, and fitted with the Low Altitude Bombing System.

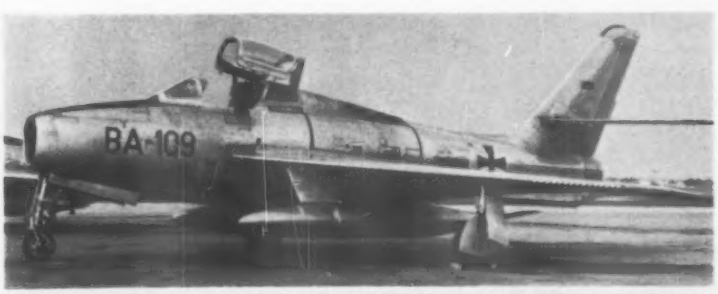
NORTHROP SCORPION **U.S.A.**

The prototype of the Northrop F-89 Scorpion two-seat twin-jet all-weather interceptor flew on August 16, 1948, and the type remained in production for the 10 years which followed. The 48 F-89As had 5,100-lb.s.t. Allison J35-A-21 turbojets and an armament of six 20-mm. guns. Forty were fitted with new tip-tanks and became F-89Bs. Next came 164 F-89Cs with more advanced fire-control radar and either two 5,400-lb. J35-A-33s or 5,600-lb. J35-A-47s. A new armament of 104 air-to-air rockets in wing-tip pods was introduced on the F-89D, which had J35-A-47s or -35s, and this was followed by the F-89H, also with J35-A-35s. Most important innovation on the "H" was redesign of the pods to house three Falcon missiles and 21 rockets each. This version also carries nuclear-warhead Genies, and earlier models have been brought up to "H" standard as F-89Js.

NORTHROP N-156 **U.S.A.**

Northrop are developing a new family of lightweight supersonic military aircraft under the designation of N-156, each powered by two General Electric J85 turbojets. First to fly, on April 10, 1959, was the tandem two-seat T-38 Talon trainer, which is in production as a potential replacement for the Lockheed T-33A. It has been followed by the N-156F Freedom Fighter (illustrated), which flew for the first time on July 30, 1959. The N-156F is a single-seater, armed with a wide variety of weapons, including wingtip Sidewinder missiles and underwing bombs, rockets or fuel tanks. Much of its structure is common with the T-38 and it is in parallel production, for M.D.A.P. air forces.





REPUBLIC THUNDERSTREAK **U.S.A.**

Republic initiated the Thunderstreak as a private-venture development of the F-84 Thunderjet with swept wings and, on the second prototype, a Wright J65 turbojet instead of the original Allison J35. The improvement in performance was so marked that the U.S.A.F. eventually had a total of 2,711 similar F-84F Thunderstreaks, passing on many of them to the air forces of Belgium, Federal Germany, France, Italy and the Netherlands. Standard armament of these aircraft is six 0.5-in. machine-guns and 6,000 lb. of external stores, including nuclear weapons. All air forces equipped with the F-84F also have RF-84F Thunderflash reconnaissance aircraft, with camera-carrying nose, wing-root air intakes and only four guns. Others of the 715 built have gone to Denmark, Greece, Taiwan, Norway and Turkey.

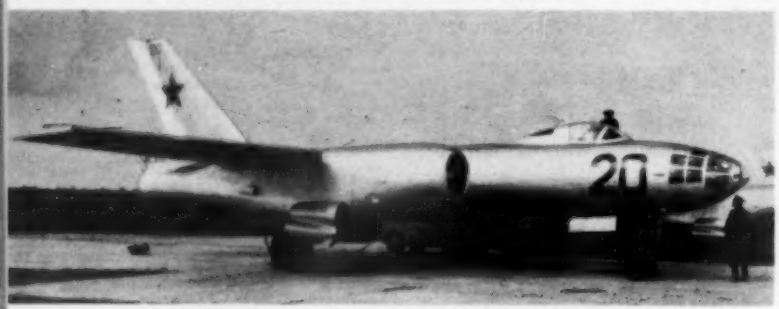
REPUBLIC THUNDERCHIEF **U.S.A.**

The Republic F-105 Thunderchief is the most powerful single-seat attack fighter in the World. The XF-105A prototype, which flew on October 22, 1955, and YF-105A had a J57 turbojet, but this was changed for a much more powerful J75-P-3 or -5 with reheat on the F-105B initial production model. Other changes included the introduction of double-shock wing-root air intakes, an area-ruled fuselage, an advanced fire-control system and a "toss-bombing" computer for use during low-level delivery of nuclear weapons. Current production version is the F-105D, with more powerful engine and full all-weather capabilities. Armament comprises one Vulcan 20-mm. gun, nuclear weapons in an internal bomb-bay and 4,000 lb. of external stores.

Military Aircraft . . . .

SIKORSKY HSS-2 **U.S.A.**

Possibly the most advanced helicopter yet put into production for military use, the HSS-2 is one of Sikorsky's versatile new family of boat-hulled amphibians. It is in production for the U.S. Navy as an all-weather anti-submarine aircraft, and is the first American helicopter equipped to fulfil the dual rôle of hunter-killer. A transport version known as the HR3S-1 has been ordered for the U.S. Marine Corps. This will have a rear loading ramp and will be able to carry 20-25 passengers or 6,000 lb. of internal or external freight. The HSS-2 is also serving as the prototype for the commercial S-61, which will differ mainly in having a third engine.



ILYUSHIN IL-28 **U.S.S.R.**

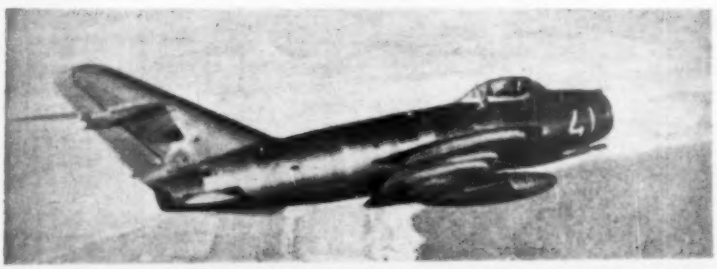
First seen over Moscow on May Day, 1950, the Ilyushin Il-28 is Russia's counterpart to the Canberra, with comparable performance and payload. Like the contemporary MiG-15 and other types, it has VK-1 turbojets, developed by Klimov from the Rolls-Royce Nene and in about the same class as the Tay. Some 4,000-6,000 lb. of bombs are carried internally, and the Il-28 is also armed with two 23-mm. guns in its nose and two more in a manned tail-turret. Production of the Il-28 totals several thousand, in Czechoslovakia as well as Russia, and many have been exported to Afghanistan, China, Egypt, Indonesia, Poland and Rumania. The crew numbers four. An operational trainer variant, the Il-28U, has a second cockpit in the nose.

ILYUSHIN " BLOWLAMP " **U.S.S.R.**

Although Western visitors to the annual Soviet Aviation Day display in 1956 were shown an example of this twin-jet Ilyushin bomber at Kubinka airfield, very little is known about it. Clearly it was intended to replace the Il-28 as a standard tactical bomber in the important Frontovaia Aviatsiya army support force, and it is assumed to be in service in considerable numbers. Most obvious changes, compared with the earlier bomber, are the introduction of swept wings, and the use of a tandem-wheel main undercarriage, with wingtip balancer wheels which retract into fairings. The tail gun-turret is retained.

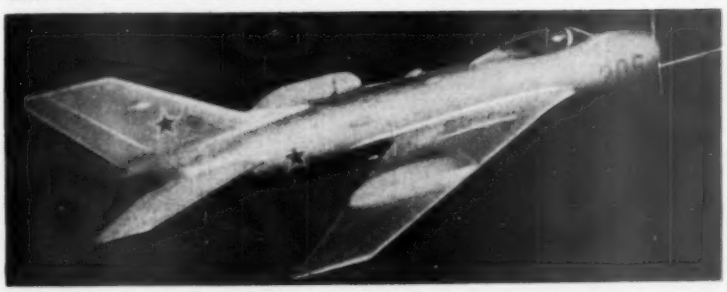
MIG-17 **U.S.S.R.**

Despite its generally good performance, the MiG-15 could not be dived at supersonic speed; so Mikoyan and Gurevich produced in the early fifties a much-refined single-seat fighter on the same lines, designated the MiG-17. The initial versions used the same VK-1 engine as the later-type MiG-15; but the most widely used variant, known in the West by the code-name " Fresco-C," has an afterburner and underwing tanks, giving an all-round improvement in performance. Standard armament is one 37-mm. and two 23-mm. guns, and all-weather fighter versions are in service with nose radomes. Countries using the MiG-17 include Bulgaria, China, East Germany, Egypt, Hungary, North Korea, Rumania and Syria, as well as Russia, Czechoslovakia and Poland, where it was built.



MIG-19 **U.S.S.R.**

The MiG-19, first Soviet fighter to fly supersonic in level flight, has followed the MiG-17 into quantity production in Russia, Czechoslovakia, Poland and, possibly, China. Its thin 45° swept wings, one-piece tailplane and powerful twin turbojets put it in much the same class as the American Super Sabre; and there are persistent reports that the original four-cannon armament has been supplemented or replaced by air-to-air rocket packs and guided missiles. Under-wing drop tanks are often carried, and a photograph has been released showing a MiG-19 being launched from a missile-type zero-length ramp.

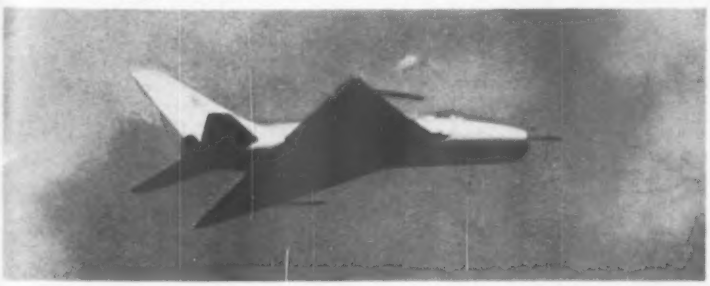


MIG-21 **U.S.S.R.**

In 1956, the last occasion on which numbers of new prototype military aircraft took part in the Aviation Day fly-past over Moscow, two single-seat interceptors were seen and were subsequently given the NATO code-names of " Faceplate " and " Fitter." " Faceplate " was identified as the MiG-21 by a Soviet commentator and is now reported to be in squadron service. It bears a distinct family likeness to the MiG-19, but is slimmer, with a wing sweep of about 58°, and is estimated to have a performance comparable with that of the best current interceptors in the West. It has reverted to a single turbojet, with a centre-body air intake, and appears to have three guns mounted under its fuselage.

MYASISHCHEV "BISON" **U.S.S.R.**

When Western observers first caught sight of V.M. Myasishchev's mighty four-jet bomber, which has the NATO code-name of "Bison," they regarded it as Russia's answer to the B-52 Stratofortress. In fact, it was flying and in production at least as early as its U.S. counterpart and was designed for the same task of delivering the newly developed H-bomb over intercontinental ranges. Like all first-generation Soviet jet-bombers, it lacks high-altitude performance; but has a great range, which can be extended by flight refuelling. Because it cannot fly high, it has a heavy defensive armament, believed to comprise 10 23-mm. guns in five remotely controlled turrets. Its undercarriage is of the tandem-wheel type, with wingtip balancer wheels.



SUKHOI "FISHPOT" **U.S.S.R.**

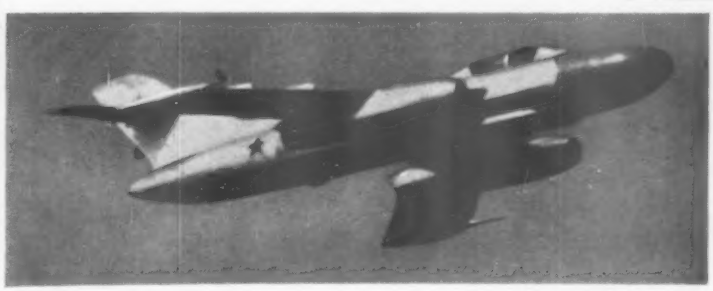
Also in the 1956 fly-past over Moscow were three delta-wing fighters designed by Pavel Sukhoi. There have since been many reports that formations of these aircraft have been sighted, and it seems likely that at least one of them is in squadron service. It is also probable that the "E-66" delta which set up a World speed record of 1,493 m.p.h. last year, and the "T-431" which established a height record of 94,657 ft., were developments of the 1956 Sukhoi prototypes. The one illustrated here is a single-seat all-weather fighter (code-name "Fishpot") with a very long fuselage and nose radome. Its wings appear to have a 60° sweep on the leading-edge, and there seems to be a gun or rocket-launcher forward of each wing-root.

TUPOLEV TU-16 **U.S.S.R.**

As the Tupolev Tu-104 airliner is based largely on the design of the Tu-16 twin-jet medium bomber, more is known about this Soviet warplane than about most of its contemporaries in the Red Air Force. It seems to be in the same class as the Vickers Valiant, except in terms of altitude performance, this latter deficiency explaining the presence of three twin-gun turrets, with a further fixed 23-mm. gun in the nose. The Tu-16 was first seen in 1954 and it is likely that well over 1,000 are in service. As in the case of other Soviet turbine-powered bombers, its operational radius can be extended indefinitely by flight refuelling.

TUPOLEV TU-20 **U.S.S.R.**

Tupolev's huge four-turboprop bomber, which is known in the West as "Bear" and is probably designated the Tu-20, forms the basis of the design of the Tu-114 airliner. One can, therefore, estimate its size and performance with some confidence, and it becomes clear that "Bear" must be the heaviest and fastest propeller-driven aircraft ever built. Except in terms of service ceiling, its performance does not fall far short of that of the four-jet "Bison," and it offers a considerably greater range. As a result, it would seem to be potentially an ideal aircraft for service as a flight refuelling tanker for the jet bomber force. The examples seen in 1956 had a similar armament to that of the Tu-16.



YAKOVLEV YAK-25 **U.S.S.R.**

Russia's standard two-seat all-weather fighter for more than five years has been the Yakovlev Yak-25, with a performance higher than that of the contemporary British Meteor NF.14, but inferior to that of the later Javelin. The design is fairly conventional, with 45° swept wings, the most unusual feature being the tandem-wheel main undercarriage, with wing tip balancer wheels. The standard armament consists of an under-fuselage tray of about 50 air-to-air rockets, flanked by a pair of 37-mm. guns. Variants of the basic Yak-25 seen in 1956 included one with an aerodynamically-better pointed nose radome and another with a glazed nose, which could be intended as a tactical fighter-bomber. It is not known if these are in service.

YAKOVLEV "BACKFIN" **U.S.S.R.**

First reported in 1957, the Yakovlev twin-jet medium bomber known as "Backfin" in the West is clearly a potential replacement for the Tu-16. News items in the East European Press have claimed that it is in service, and have given detailed performance figures; but these contain apparent discrepancies. The reported max. speed of Mach 1.3 seems low for an efficient modern design with two turbojets in the 20,000-lb.s.t. class. On the other hand, all illustrations have depicted the aircraft with a glazed nose, which would seem a strange feature to find on a highly supersonic aircraft. "Backfin" remains, therefore, very much an unknown quantity.

Military Aircraft of the World

Aircraft	Duty	Status	Crew	Powerplant	Dimensions			Weights and loadings			Performance								
					Span	Length	Wing area	Empty	Normal take-off	Wing loading	Max. speed		Initial climb	Service ceiling	T.-o. to 50 ft.	Typical range			
					ft. in.	ft. in.	sq. ft.	lb.	lb.	lb./sq. ft.	m.p.h.	ft.	ft./min.	ft.	ft.	miles	m.p.h.	ft.	gal.
AUSTRALIA																			
Commonwealth																			
CA-25 Winjeel	T.	Serv.	3	1×445-h.p. P. & W. R-985-AN2	38 7½	28 0½	249	3,370	4,346	17.4	186	S.L.	1,500	18,000	1,110	550	158	5,000	69
CA-27 Avon-Sabre Mk. 32	F.	Serv.	1	1×7,500-lb. Avon 26	37 1	37 6	312	N.A.	15,800	54.9	700	S.L.	12,000	45,000+	N.A.	1,700+	N.A.	N.A.	N.A.
CANADA																			
Avro																			
CF-100 Mk. 5	A.F.	Serv.	2	2×7,275-lb. Orenda 11	60 10	54 2	591	23,100	33,600	56.8	*650*	*10,000*	*8,500*	*55,000*	N.A.	*2,000*	N.A.	N.A.	N.A.
Canadair																			
Sabre 6	F.	Serv.	1	1×7,275-lb. Orenda 14	37 1	37 6	288	11,143	16,426	57.0	710	S.L.	11,800	N.A.	N.A.	1,495	N.A.	N.A.	N.A.
CL-28 (CP-107) Argus	M.R.	Serv.	15	4×3,700-h.p. Wright R-3350 TC18EA1	142 3½	128 3	2,075	81,000	148,000	71.3	288	S.L.	N.A.	20,000+	N.A.	4,000+	180	S.L.	7,188
CL-44 (CC-106)	Tp.	Prod.	4+189	4×5,730-e.h.p. Tyne R. Ty. 12	142 3½	136 7½	2,075	91,730	205,000	99.0	N.A.	N.A.	N.A.	N.A.	7,660*b*	6,330*n*	374	25,500	10,150
Canadair 540 (CC-109)	Tp.	Prod.	2–4+ 48–58	2×3,500-h.p. Eland 504A	105 4	81 6	920	32,980	53,200	57.8	340	20,000	N.A.	N.A.	4,550*b*	1,244	322	20,000	1,692
De Havilland																			
DHC-2 Beaver	Tp.	Serv.	1+7	1×450-h.p. P. & W. R-985	48 0	30 3	250	2,850	5,100	20.4	163	5,000	1,020	18,000	1,015	455	143	5,000	79
DHC-3 Otter	Tp.	Serv.	1+10	1×600-h.p. P. & W. R-1340-S1H1-G	58 0	41 10	375	4,168	8,000	21.3	160	5,000	735	18,800	1,310	960	138	5,000	178
DHC-4 Caribou	Tp.	Dev.	2+32	2×1,450-h.p. P. & W. R-2000-7M2	96 0	72 7	912	16,500	26,000	28.5	214	S.L.	1,575	27,700	1,020	1,450	148	7,500	700
INDIA																			
Hindustan																			
HT-2	T.	Serv.	2	1×155-h.p. Cirrus Major III	35 2	24 8½	173.4	1,540	2,240	12.9	130	S.L.	800	14,500	N.A.	350	115	1,000	26
FRANCE																			
Breguet																			
1050 Alizé	A.S.	Prod.	3	1×1,975-h.p. Dart R. Da. 21	51 2	45 6	387.5	12,566	18,078	46.7	285	S.L.	1,380	20,000	1,890*u*	*700*	140	1,000	462
1150 Atlantic	M.R.	Dev.	9–10	2×6,000-e.h.p. (+) Tyne R. Ty. 20	124 0	89 6	1,292	N.A.	86,000	66.5	N.A.	N.A.	N.A.	N.A.	N.A.	*20 hr.*	N.A.	N.A.	N.A.
Dassault																			
Mystère IVA	F.	Serv.	1	1×7,700-lb. Verdon 350	36 5½	42 1½	344.3	12,496	16,535	48.0	695	S.L.	8,850	N.A.	N.A.	70 min.	N.A.	N.A.	572
Super-Mystere B-2	F.	Serv.	1	1×9,700-lb. Atar 101G(R)	34 6	46 1	377	15,400	19,840	52.6	745	36,000	17,500	55,750	N.A.	60 min.	N.A.	N.A.	N.A.
Etendard IV-M	F.	Prod.	1	1×9,700-lb. Atar 8	31 6	47 3	312	N.A.	19,400	62.2	M=1.06	36,000	N.A.	N.A.	2,295*u*	800	N.A.	N.A.	726
Mirage III-C	F.	Prod.	1	1×14,090-lb. Atar 9(R)+1×3,700-lb. SEPR 841	26 11	45 5	366	12,350	18,740	51.2	M=2.3	36,000	20,000	80,000+	*2,300u*	*745*	*M=0.9*	36,000	572
Mirage IV	B.	Dev.	2	2×16,534-lb. Atar 9J (R)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	M=2+	40,000	N.A.	N.A.	N.A.	2,000+	N.A.	N.A.	N.A.
Max Holste																			
M.H.1521 Broussard	Tp.	Serv.	1+5	1×450-h.p. P. & W. R-985-AN-1	45 0	28 2½	273.4	3,373	5,511	20.2	168	3,000	1,082	18,045	1,065	745	136	3,000	97
Nord-Aviation																			
2501 Noratlas	Tp.	Serv.	5	2×2,040-h.p. Hercules 738 or 758	106 7	72 1	1,089	29,425	50,705	46.5	273	5,000	1,075	22,100	2,700	1,710	198	10,000	1,120
3202	T.	Prod.	2	1×240-h.p. Potez 4.D-32	31 2	26 8	177.5	1,813	2,690	15.2	161	S.L.	1,180	N.A.	N.A.	620	N.A.	N.A.	N.A.
3400	O.	Prod.	2	1×260-h.p. Potez 4.D-34	43 0	27 8	210	2,028	2,975	14.2	147	S.L.	1,375	N.A.	320*u*	620	124	1,000	48.4
Transall C.160	Tp.	Dev.	N.A.	2×Tyne	131 3	97 5	N.A.	N.A.	90,390	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Potez-Air Fouga																			
Magister (Zéphyr similar)	T.	Serv.	2	2×880-lb. Marboré IIA	39 10	33 0	186.1	4,740	6,835	36.7	443	30,000	2,950	35,000	3,050	735	N.A.	30,000	215
Sud-Aviation																			
S.E.3130 Alouette II	G.P. Hel.	Serv.	5	1×400-h.p. Artouste II	33 6*	31 6	880*	1,875	3,527	4.01*	109	S.L.	880	10,500	—	330	106	S.L.	127.5
S.O. 1221 Djinn	G.P. Hel.	Serv.	2	1×240-h.p. Palouste IV	36 0*	17 4	1,022*	794	1,765	1.73*	80	S.L.	690	9,850	—	118	62	S.L.	55
S.O.4050 Vautour IIN	A.F.	Serv.	2	2×7,700-lb. Atar 101E-3	49 6½	51 1	484.4	23,150	33,070	68.3	685	S.L.	11,820	49,000	2,600*u*	1,500	N.A.	N.A.	N.A.
WEST GERMANY																			
Dornier																			
Do 27A	G.P.	Serv.	5	1×270-h.p. Lycoming GO-480-B1A6	39 4½	31 6	208.8	2,167	3,460	16.6	155	3,280	N.A.	18,040	560	540	127	3,280	48.4
ITALY																			
Fiat																			
F-86K (North American Licence)	A.F.	Serv.	1	1×7,350-lb. Gen. Elect. J47-GE-17 (R)	37 1	42 4	288	N.A.	18,000	62.5	720	S.L.	N.A.	45,000+	N.A.	1,000	N.A.	N.A.	N.A.
G.91	F.B.	Prod.	1	1×5,000-lb. Orpheus 803	28 1	34 2½	176.7	6,250	11,365	64.3	675	5,000	N.A.	N.A.	3,770	350	N.A.	N.A.	N.A.
Macchi																			
M.B.326	T.	Prod.	2	1×2,503-lb. Viper A.S.V.11	32 11	34 5	204.5	5,026	7,430	36.3	506	20,000	4,420	40,000	1,970	600	N.A.	N.A.	237
Piaggio																			
P.149-D	T./L.	Serv.	2–5	1×270-h.p. Lycoming GO-480	36 6	28 9½	203	2,557	3,704	18.2	192	S.L.	980	19,800	1,328	600	165	10,800	52.8
JAPAN																			
Fuji																			
TIF2	T.	Dev.	2	1×4,050-lb. Orpheus B.Or. 1	34 5½	39 8½	239.2	5,313	8,800	36.8	483	20,000	6,100	40,000	1,970	783	334	30,000	308

Abbreviations.—A.F., all-weather fighter; A.S., anti-submarine; B., bomber; E.W., early-warning aircraft; Ex., experimental or research aircraft; F., fighter; F.B., fighter-bomber; F.R., fighter-reconnaissance; G.P., general purpose; Hel., helicopter; L., liaison; M.R., maritime reconnaissance; O., observation; Res., rescue; S., strike; T., trainer; Tan/Tp., tanker-transport; Tp., transport; *b*, balanced field length; Dev., under development; *n*, no reserves; Prod., in production, not yet in service; Serv., in service; (R), thrust quoted with re-heat; *u*, distance to unstick; * helicopter rotor diameter, disc area and disc loading respectively. DATA IN ITALICS ARE ESTIMATED OR APPROXIMATE.

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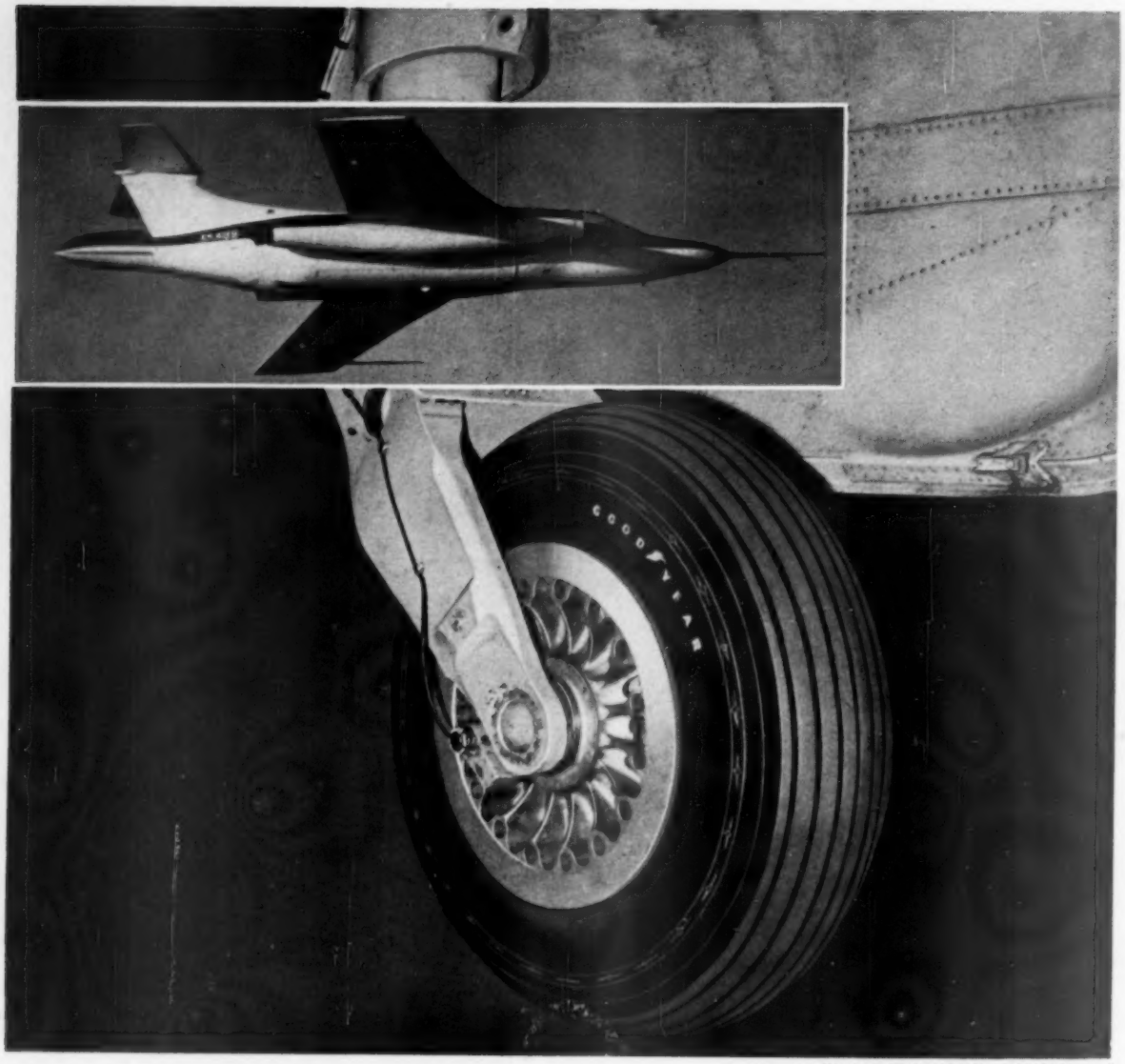

Photographs show Blackburn NA39 low-level strike aircraft, and close-up of wheel assembly. By courtesy of Blackburn Aircraft Limited.

Blackburn NA39's will come in on Goodyear

When they land, production Blackburn NA39 aircraft will be depending on tyres, wheels, brakes and anti-skid equipment by Goodyear—proved equipment that's without peer for efficiency, reliability and economy in weight.

Brakes — maximum non-fading reserve of braking power. Light and strong. Rapid cooling. Easy to maintain.

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Wheels — divided at centre to facilitate tyre-mounting and withstand strain of high landing speeds.

Tyres — Ribbed Tread design with tough, high-tensile cord carcass.

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Military Aircraft of the World . . . .

Aircraft	Duty	Status	Crew	Powerplant	Dimensions			Weights and loading			Performance							
					Span	Length	Wing area	Empty	Normal take-off	Wing loading	Max. speed		Initial climb	Service ceiling	T.-o. to 50 ft.	Typical range		
					ft. in.	ft. in.	sq. ft.	lb.	lb.	lb./sq. ft.	m.p.h.	ft.	ft./min.	ft.	ft.	miles	m.p.h.	ft.	gal.
NETHERLANDS																		
Fokker																		
F.27M Friendship	Tp.	Prod.	2+36–48	2×2,105-e.h.p. Dart R. Da. 7 Mk. 528	95 2	75 9	754	23,286	37,500	49.8	N.A.	N.A.	1,770	30,000	3,450*b*	1,740*n*	267	20,000	1,130
S.11 Instructor	T.	Serv.	2	1×190-h.p. Lycoming O–435A	36 1	26 8	199	1,785	2,425	12.2	130	S.L.	N.A.	12,600	650*u*	360	102	1,000	31
SPAIN																		
Casa																		
201 Alcotan	Tp.	Serv.	2+10	2×500-h.p. Sirio–VIIA	60 4	45 3	450	7,920	12,100	26.8	213	S.L.	N.A.	19,360	N.A.	621	193	6,500	N.A.
Hispano																		
HA–100–E1 Triana	T.	Prod.	2	1×755-h.p. Beta B–4	34 1	29 5	186.6	4,343	6,460	34.6	276	9,500	2,130	33,600	N.A.	821	237	9,500	132
HA–200–R1 Saeta	T.	Prod.	2	2×880-lb. Marboré IIA	34 2	29 1½	187.2	3,697	6,995	37.4	405	S.L.	3,345	39,350	N.A.	1,056	N.A.	32,800	270
SWEDEN																		
Saab																		
J29F	F.	Serv.	1	1×6,200-lb. Ghost 50 (R)	36 1	33 2½	258	*10,000*	*14,000*	*54.2*	658	5,000	12,000	45,000	N.A.	1,677	N.A.	N.A.	Ext. tanks
A32A Lansen	F.B.	Serv.	2	1×10,000-lb. RM5 (Avon) (R)	42 8	49 2½	402.5	*15,400*	*22,000*	N.A.	700+	S.L.	N.A.	*49,000*	N.A.	2,000+	N.A.	N.A.	N.A.
J35A Draken	F.	Prod.	1	1×15,200-lb. RM6 (Avon) (R)	30 10	53 4	538.2	N.A.	19,800	36.8	M=1.8	36,000	*39,350*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
91–D Safir	T.	Serv.	2-4	1×180-h.p. Lycoming 0–360–A1A	34 9	26 4	146.3	N.A.	2,657	18.1	165	S.L.	N.A.	16,400	N.A.	660	146	3,000	38.5
SWITZERLAND																		
Pilatus																		
P–3	T.	Prod.	2	1×260-h.p. Lycoming GO–435–C2A	34 1	28 8	177	2,447	3,120	17.7	192.5	S.L.	1,380	18,040	1,120	465	157	5,000	35.2
UNITED KINGDOM																		
Armstrong Whitworth																		
A.W.660 (data apply to A.W.650)	Tp.	Prod.	3+ up to 89	4×2,100-h.p. Dart R.Da.7/2 Mk. 526	115 0	86 9	1,458	47,421	88,000	60.4	N.A.	N.A.	*1,400*	25,000	4,650*b*	2,500	280	20,000	3,300
Sea Hawk FGA.6	F.B.	Serv.	1	1×5,400-lb. Nene RN.6 Mk. 103	39 0	39 8	278	N.A.	16,200	58.3	599	S.L.	5,700	N.A.	3,765	580	N.A.	N.A.	N.A.
Auster																		
AOP.9	O.	Serv.	3	1×173-h.p. Bombardier 203	36 5	23 8½	197.6	1,590	2,125	10.4	127	S.L.	970	19,500	675	242	110	1,000	15
Avro																		
748 Series I	Tp.	Prod.	2+36–47	2×1,740-h.p. Dart R.Da.6 Mk. 514	95 0	67 0	795	19,444	33,000	41.5	*294*	*17,000*	*1,350*	*30,500*	*3,500b*	*1,875n*	*265*	20,000	1,100
Shackleton MR.3	M.R.	Serv.	10	4×2,455-h.p. Griffon 57A	119 10	92 6	1,421	N.A.	100,000	70.4	300	12,000	850	19,200	3,820	3,660	200	1,500	4,248
Vulcan B.2	B.	Prod.	5	4×17,000-lb. Olympus 201	111 0	97 1	N.A.	N.A.	*180,000+*	N.A.	600+	50,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Blackburn																		
Beverley C.1	Tp.	Serv.	4+94	4×2,850-h.p. Centaurus 173	162 0	99 5	2,916	82,100	135,000	46.4	238	5,700	760	16,000	1,340	1,063	173	12,500	N.A.
NA.39	S.	Prod.	2	2×7,000-lb. Gyron Junior D.G.J.1	42 6	62 4	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	*1,400*	N.A.	N.A.	N.A.
Bristol																		
Britannia C.1	Tp.	Serv.	4–7+115	4×4,445-h.p. Proteus 255	142 3½	124 3	2,075	88,250	180,000	86.7	405	22,000	1,290	29,000	7,600	5,520	357	23,000	8,580
Sycamore HR.14	G.P. Hel.	Serv.	1+4	1×520-h.p. Leonides Mk. 173	48 7*	46 2	1,856*	4,150	5,600	2.9*	127	S.L.	1,200	14,500	—	268	91	2,000	65
Belvedere (Type 192)	G.P. Hel.	Prod.	2+18–25	2×1,650-h.p. Gazelle 100	48 8*	54 4	2×1,860*	10,913	18,000	4.84*	150	2,000	1,175	13,250	—	432	138	S.L.	560
De Havilland																		
Comet C.2	Tp.	Serv.	4+48	4×7,350-lb. Avon Mk. 117/118	115 0	96 0	2,027	55,300	122,000	60.2	508	40,000	N.A.	N.A.	6,100	2,535	480	36,000	6,906
Sea Vixen FAW.1	A.F.	Serv.	2	2×10,000-lb. Avon 200 Series	50 0	53 6½	N.A.	N.A.	*35,000*	N.A.	*690*	*10,000*	*10,000+*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Vampire T.11	T.	Serv.	2	1×3,500-lb. Goblin 35	38 0	34 6½	261	7,700	11,150	42.7	549	20,000	4,500	40,000	2,730	850	403	40,000	330
English Electric																		
Canberra B(1).8	B.	Serv.	2	2×7,500-lb. Avon 109	63 11½	65 6	960	N.A.	45,000+	N.A.	*580*	40,000	N.A.	*55,000*	N.A.	*3,000*	N.A.	N.A.	Ext. tanks
Canberra PR.9	P.R.	Serv.	2	2×10,050-lb.s.t. Avon 206	67 10	66 8	N.A.	N.A.	N.A.	N.A.	*600+*	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lightning F.1	A.F.	Prod.	1	2×17,250-lb. Avon R.A.24R (R)	34 10	50 0	N.A.	N.A.	N.A.	N.A.	M=2+	40,000	N.A.	60,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Lightning T.4	T.	Prod.	2	2×17,250-lb.s.t. Avon R.A.24R (R)	34 10	50 0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Fairey																		
Gannet AEW.3	E.W.	Prod.	3	1×3,875-h.p. Double Mamba ASMD.8	54 6	44 0	490	N.A.	*21,000*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Folland																		
Gnat Trainer	T.	Prod.	2	1×4,230-lb. Orpheus 100	24 0	30 9	175	5,070	7,435	42.5	M=0.95+	36,000	N.A.	N.A.	1,560*u*	2 hr. 15 min.	N.A.	N.A.	Ext. tanks
Gnat F.1	F.	Serv.	1	1×4,520-lb.s.t. Orpheus 701	22 2	29 9	136.6	4,850	6,650	48.7	M=0.98	36,000	N.A.	50,000+	2,620	1,000	N.A.	N.A.	332
Gloster																		
Javelin FAW.8	A.F.	Serv.	2	2×12,300-lb. Sapphire 200 Series (R)	52 0	56 9	N.A.	N.A.	*32,000+*	N.A.	*710*	10,000	*12,000+*	*55,000*	N.A.	N.A.	N.A.	N.A.	N.A.
Handley Page																		
Hastings C.2	Tp.	Serv.	5+50	4×1,675-h.p. Hercules 106	113 0	81 8	1,408	48,427	80,000	56.8	348	22,200	890	26,500	1,586	4,250	291	15,200	3,172
Victor B.2	B.	Prod.	5	4×17,250-lb. Conway R.Co.11	120 0	114 11	N.A.	N.A.	N.A.	N.A.	*600+*	50,000	N.A.	*55,000+*	N.A.	N.A.	NA.	N.A.	N.A.
Hawker																		
Hunter F.6	F.	Serv.	1	1×10,000-lb. Avon 203	33 8	45 10¼	349	*13,500*	*17,500*	N.A.	*700+*	S.L.	*15,000*	*55,000*	N.A.	*550*	*560*	*36,000*	*410*
Hunter T.66	T.	Serv.	2	1×10,000-lb.s.t. Avon 203	33 8	48 10¼	349	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	51,000	3,150	1,025	N.A.	N.A.	200 Ext.
Hunting																		
Jet Provost T.3	T.	Serv.	2	1×1,750-lb. Viper 102	36 11	32 5	213.7	4,347	7,092	33.2	326	25,000	2,400	35,000	1,990	565	273	25,000	286
Pembroke C.1	Tp.	Serv.	2+8	2×550-h.p. Leonides 127	64 6	46 0	400	9,178	13,500	33.8	224	2,000	1,070	22,000	2,520	1,150	155	8,000	232
Provost T.1	T.	Serv.	2	1×550-h.p. Leonides 126	35 2	28 8	214	3,350	4,400	20.6	200	2,300	2,200	22,500	850	700	177	11,000	66

Abbreviations.—A.F., all-weather fighter; A.S., anti-submarine; B., bomber; E.W., early-warning aircraft; Ex., experimental or research aircraft; F., fighter; F.B., fighter-bomber; F.R., fighter-reconnaissance; G.P., general purpose; Hel., helicopter; L., liaison; M.R., maritime reconnaissance; O., observation; Res., rescue; S., strike; T., trainer; P.R., photo-reconnaissance; Tp., transport; *b*, balanced field length; Dev., under development; *n*, no reserves; Prod., in production, not yet in service; Serv., in service; (R), thrust quoted with re-heat; *u*, distance to unstick; * helicopter rotor diameter, disc area and disc loading respectively. DATA IN ITALICS ARE ESTIMATED OR APPROXIMATE.

Military Aircraft of the World . . . .

Aircraft	Duty	Status	Crew	Powerplant	Dimensions: Span	Length	Wing area	Weights and loading: Empty	Normal take-off	Wing loading	Performance: Max. speed		Initial climb	Service ceiling	T.-o. to 50 ft.	Typical range:			
					ft. in.	ft. in.	sq. ft.	lb.	lb.	lb./sq. ft.	m.p.h.	ft.	ft./min.	ft.	ft.	miles	m.p.h.	ft.	gal.
Saunders-Roe																			
Skeeter 12	G.P. Hel.	Serv.	2	1×215-h.p. Gipsy Major 215	32 0°	26 8	804°	1,656	2,200	2.86°	104	S.L.	1,150	12,800	—	213	86	1,000	23
Wasp (P.531-2 Mk. 1)	G.P. Hel.	Dev.	5–6	1×968-h.p. Blackburn Nimbus	32 3°	30 4	817°	2,749	5,000	6.13°	128	S.L.	600 vert.	N.A.	—	315	115	S.L.	158
Scottish Aviation																			
Pioneer CC.1	G.P.	Serv.	1+4	1×540-h.p. Leonides 503/7	49 9	34 4½	390	4,180	5,800	14.9	145	1,500	720	15,850	600	650	114	5,000	120
Twin Pioneer Series 3	Tp.	Serv.	2+16	2×600-h.p. Leonides 531/8	76 6	45 3	670	10,287	14,600	21.8	162	2,000	920	18,000	1,100	670	131	5,000	371
Short																			
Britannic	Tp.	Dev.	4+201	4×5,730-h.p. Tyne R.Ty.12	158 9½	136 5	2,466	111,000	218,000	88.5	N.A.	N.A.	N.A.	N.A.	6,950*b*	6,390*n*	*350*	28,000	10,150
Supermarine																			
Scimitar F.1	F./S.	Serv.	1	2×11,250-lb. Avon 200 Series	37 2	55 4	N.A.	N.A.	*40,000*	N.A.	*710*	10,000	12,000+	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Vickers-Armstrongs																			
Valiant B (K).1	B.	Serv.	5	4×10,000-lb. Avon 204	114 4	108 3	2,362	N.A.	*160,000*	N.A.	600+	40,000	5,000+	45,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Westland																			
Wessex	A.S. Hel.	Prod.	5–6	1×1,430-h.p. Gazelle N.Ga.13	56 0°	56 7½	2,460°	8,350	12,600	5.13°	144	S.L.	1,750	14,000	—	390	115	S.L.	300
Whirlwind HAS.7	A.S. Hel.	Serv.	4–5	1×750-h.p. Leonides Major 155	53 0°	41 8½	2,206°	5,375	7,800	3.53°	109	S.L.	1,080	13,200	—	334	86	S.L.	170
Gnome-Whirlwind	G.P. Hel.	Dev.	2+10	1×1,024-h.p. Gnome H1000	53 0°	44 2	2,206°	4,761	8,000	3.63°	109	S.L.	1,100	N.A.	—	275	104	S.L.	170
U.S.A.																			
Beech																			
T-34B Mentor	T.	Serv.	2	1×225-h.p. Continental O-470-13	32 10	25 11	177.6	2,228	2,985	16.75	188	S.L.	1,160	19,500	1,200	728	170	10,000	41.6
Bell																			
H-13H Sioux	G.P. Hel.	Serv.	3	1×200-h.p. Lycoming VO-435	35 1½°	27 4	965°	1,564	2,450	2.54°	100	S.L.	1,065	14,950	—	238	85	1,000	36
HU-1A Iroquois	G.P. Hel.	Prod.	1+5	1×700-h.p. Lycoming T53-L-1	44 0	39 7½	1,520°	3,834	5,800	3.80°	141	S.L.	2,100	N.A.	—	210+	115	1,000	104
Boeing																			
B-47E Stratojet	B.	Serv.	3	6×6,000-lb. Gen. Elect. J47-GE-25A	116 0	109 10	N.A.	N.A.	200,000+	N.A.	630	10,000	N.A.	42,000	N.A.	3,200	495	40,000	N.A.
B-52G Stratofortress	B.	Prod.	6	8×*13,750*-lb. P. & W. J57-P-43W	185 0	157 7	*4,000*	N.A.	480,000	*120.0*	650+	20,000	N.A.	50,000+	N.A.	*10,000*	N.A.	N.A.	N.A.
KC-97G Stratofreighter	Tan/Tp.	Serv.	5+65	4×3,250-h.p. P. & W. R-4360-59B	141 3	110 4	1,769	82,500	153,000	86.5	375	10,000	N.A.	35,000+	N.A.	4,300	300	20,000	7,790
KC-135A Stratotanker	Tan/Tp.	Serv.	4+80	4×11,800-lb. P. & W. J57-P-31	130 10	136 3	2,433	N.A.	297,000	122.1	642	10,000	N.A.	45,000	N.A.	N.A.	N.A.	N.A.	14,488
Cessna																			
L-19E Bird Dog	O./L.	Serv.	2	1×213-h.p. Continental O-470-11	36 0	25 10	174	1,614	2,430	13.79	115	1,000	1,150	18,500	560	530	104	5,000	34
T-37B	T.	Serv.	2	2×1,025-lb. Continental J69-T-25	33 9½	29 3	183.9	N.A.	6,574	35.7	425	20,000	3,370	38,700	2,025	932	333	35,000	257
Chance Vought																			
F8U-2 Crusader II	F.	Serv.	1	1×16,900-lb. P. & W. J57-P-16 (R)	35 8	54 2½	N.A.	*16,500*	*27,000*	N.A.	*M=1.8*	*36,000*	*15,000+*	*54,000*	N.A.	*560*	N.A.	N.A.	N.A.
Convair																			
B-58A Hustler	B.	Prod.	3	4×15,000-lb. Gen. Elect. J79 (R)	57 0	97 0	N.A.	N.A.	*160,000*	N.A.	*M=2*	*36,000*	N.A.	*60,000*	N.A.	N.A.	N.A.	N.A.	N.A.
C-131A Samaritan	Tp.	Serv.	3+39	2×2,500-h.p. P. & W. R-2800-99W	91 9	74 8	817	29,000	43,575	53.3	313	10,000	1,410	24,500	3,300	1,600	272	10,000	1,274
F-102A Delta Dagger	A.F.	Serv.	1	1×17,000-lb. P. & W. J57-P-35 (R)	38 1½	68 3	661.5	N.A.	*27,000*	N.A.	M=1.25	36,000	*12,000*	54,000	N.A.	N.A.	N.A.	N.A.	N.A.
F-106A Delta Dart	A.F.	Serv.	1	1×24,500-lb. P. & W. J75-P-17 (R)	38 3½	70 8½	631.3	N.A.	*30,000*	N.A.	M=2.3	*40,000*	N.A.	*60,000*	N.A.	N.A.	N.A.	N.A.	N.A.
Douglas																			
A3D-2 Skywarrior	B.	Serv.	3	2×10,500-lb. P. & W. J57-P-10	72 6	75 8	730	38,000	70,000	95.9	630	S.L.	N.A.	45,000	N.A.	2,000+	N.A.	N.A.	N.A.
A4D-2N Skyhawk	S.	Serv.	1	1×7,700-lb. Wright J65-W-16A	27 6	42 10½	260	N.A.	17,295	66.5	680	S.L.	N.A.	N.A.	N.A.	1,150	N.A.	N.A.	641
B-66B Destroyer	B.	Serv.	3	2×10,200-lb. Allison J71-A-13	72 6	75 2	780	42,788	78,000	100.0	620	10,000	N.A.	40,000+	N.A.	1,500+	N.A.	N.A.	3,872
C-124C Globemaster II	Tp.	Serv.	5+200	4×3,800-h.p. P. & W. R-4360-63A	174 1½	130 5	2,506	101,165	185,000	73.8	304	20,800	760	22,100	N.A.	6,280	272	13,600	9,160
C-133B Cargomaster	Tp.	Serv.	6+200+	4×7,500-h.p. P. & W. T34-P-9W	179 8	157 6½	2,673.1	120,363	286,000	107.0	N.A.	N.A.	*1,000+*	N.A.	*5,000u*	4,000	323	20,000	15,080
F4D-1 Skyray	F.	Serv.	1	1×14,500-lb. P. & W. J57-P-8 (R)	33 6	45 8½	557	N.A.	21,000	37.7	M=1.05	36,000	18,000	55,000	N.A.	950	N.A.	N.A.	Ext. tanks
Fairchild																			
C-119G Packet	Tp.	Serv.	4	2×3,350-h.p. Wright R-3350-89WA	109 3	86 6	1,447	39,982	74,400	51.4	296	17,000	750	N.A.	N.A.	2,300	205	15,000	2,185
C-123B Provider	Tp.	Serv.	2+60	2×2,500-h.p. P. & W. R-2800-99W	110 0	76 3	1,223.2	31,620	56,500	49.0	253	10,000	1,105	24,000	N.A.	2,340	186	10,000	1,967
Grumman																			
F9F-8T Cougar	F./T.	Serv.	2	1×7,250-lb. P. & W. J48-P-8A	34 6	48 6½	N.A.	N.A.	20,600	N.A.	*700*	S.L.	N.A.	N.A.	N.A.	1,000	N.A.	N.A.	Ext. tanks
F11F-1 Tiger	F.	Serv.	1	1×10,500-lb. Wright J65-W-18 (R)	31 7½	44 6	249.72	N.A.	13,850	55.5	*M=1.35*	36,000	*16,000*	*55,000*	N.A.	*600*	N.A.	N.A.	N.A.
SA-16B Albatross	Res.	Serv.	4+10	2×1,425-h.p. Wright R-1820-76A	96 6	62 4	N.A.	25,600	32,100	N.A.	277	N.A.	N.A.	N.A.	N.A.	N.A.	230	N.A.	N.A.
S2F-1 Tracker	A.S.	Serv.	4	2×1,525-h.p. Wright R-1820-82	69 8	42 3	485	N.A.	21,000	43.3	N.A.	N.A.	N.A.	N.A.	N.A.	1,300	N.A.	N.A.	N.A.
YAO-1 Mohawk	O.	Prod.	2	2×1,005-h.p. Lycoming T53-L-3	42 0	41 0	330	7,772	10,423	31.6	316	5,000	3,000	32,500	655	460	230	5,000	230
Hayes-Boeing																			
KB-50J Superfortress	Tan/Tp.	Serv.	5	4×3,500-h.p. P. & W. R-4360-35+2×6,000-lb. J47	141 2	105 2	1,720	N.A.	173,000	100.5	445	17,000	1,375	40,500	5,030	2,300	263	25,200	6,893
Hiller																			
H-23D Raven	G.P. Hel.	Serv.	3	1×250-h.p. Lycoming VO-435-23B	35 0°	28 0	985°	1,780	2,700	2.74°	95	S.L.	1,050	13,200	—	205	82	1,000	40
Kaman																			
HOK-1 (and H-43A)	G.P. Hel.	Serv.	1+3–4	1×600-h.p. P. & W. R-1340-48	47 0°	25 0	3,470°	4,040	5,800	1.67°	109	8,000	1,300	18,000	—	220	75	1,000	83.3
H-43B Huskie	Res. Hel.	Prod.	1+7	1×720-h.p. Lycoming T53-L-1A	47 0°	25 0	3,470°	4,278	5,870	1.69°	120	S.L.	2,000	25,700	—	210	113	1,000	165
HU2K-1	G.P. Hel.	Prod.	11	1×1,025-h.p. Gen. Elect. T58-GE-6	44 0°	52 2	1,520°	5,052	9,152	6.02°	N.A.	N.A.	N.A.	N.A.	—	N.A.	N.A.	N.A.	230
Lockheed																			
C-130B Hercules	Tp.	Serv.	4+92	4×4,050-h.p. Allison T56-A-7A	132 7	97 8	1,745	69,300	135,000	77.3	N.A.	N.A.	2,150	35,000+	4,370	3,900	350	22,200	5,795
F-104C Starfighter	F.	Serv.	1	1×15,560-lb. Gen. Elect. J79-GE-7 (R)	21 11	54 9	196.1	*11,500*	*17,000*	N.A.	*M=2.2*	40,000	*15,000+*	*70,000*	N.A.	N.A.	N.A.	N.A.	N.A.
P2V-7 Neptune	M.R.	Serv.	7	2×3,500-h.p. Wright R-3350-32W+2×3,400-lb. Westinghouse J34-WE-34	103 10	91 8	1,000	47,450	75,500	75.5	356	10,000	N.A.	31,170	N.A.	3,850	N.A.	N.A.	1,832
YP3V-1	M.R.	Dev.	10	4×4,585-h.p. Allison T56-A-10W	99 0	113 7	1,300	N.A.	125,500	96.5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7,660
T-33A	T.	Serv.	2	1×5,200-lb. Allison J33-A-35	38 10½	37 9	237	8,400	11,965	50.5	600	S.L.	5,525	47,500	2,560	1,345	N.A.	N.A.	Ext. tanks
T2V-1 SeaStar	T.	Serv.	2	1×6,100-lb. Allison J33-A-22	42 10	38 6½	N.A.	11,500	15,500	N.A.	580	35,000	5,400	40,000	N.A.	960	N.A.	N.A.	633
WV-2 (and RC-121C)	E.W.	Serv.	22	4×3,500-h.p. Wright R-3350-34	123 0	116 2	1,650	N.A.	140,000	84.8	*305*	20,000	N.A.	N.A.	N.A.	*4,400*	*245*	25,000	5,454

Abbreviations.—A.F., all-weather fighter; A.S., anti-submarine; B., bomber; E.W., early warning aircraft; Ex., experimental or research aircraft; F., fighter; F.B., fighter-bomber; F.R., fighter-reconnaissance; G.P., general purpose; Hel., helicopter; L., liaison; M.R., maritime reconnaissance; O., observation; Res., rescue; S., strike; T., trainer; Tan/Tp., tanker-transport; Tp., transport; *b*, balanced field length; Dev., under development; *n*, no reserves; Prod., in production, not yet in service; Serv., in service; (R), thrust quoted with re-heat; *u*, distance to unstick; ° helicopter rotor diameter, disc area and disc loading respectively. DATA IN ITALICS ARE ESTIMATED OR APPROXIMATE.

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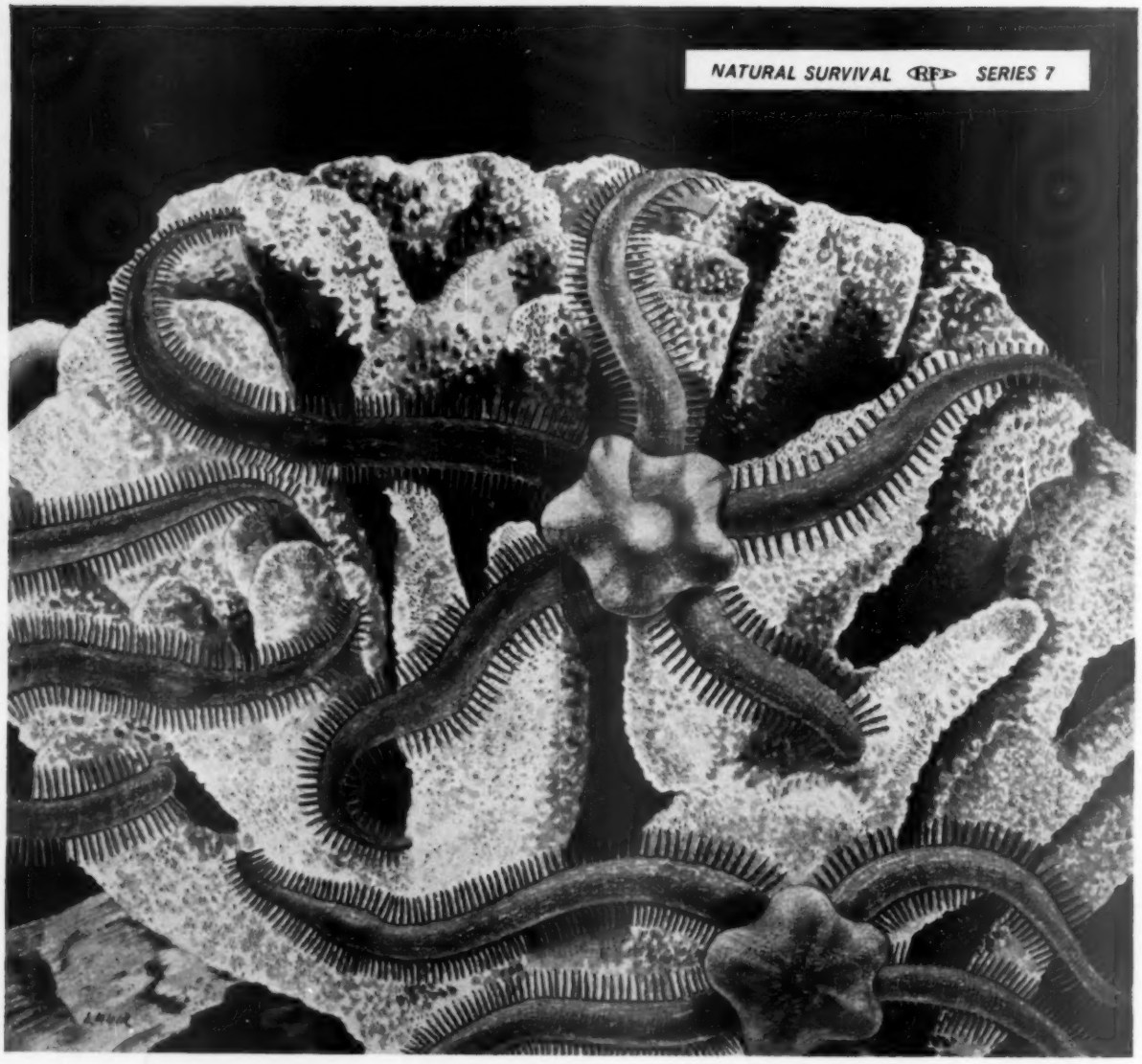

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					ft. in.	ft. in.	sq. ft.	lb.	lb.	lb./sq. ft.	m.p.h.	ft.	ft./min.	ft.	ft.	miles	m.p.h.	ft.	gal.
McDonnell																			
F-101C Voodoo	F.	Serv.	1	2×14,500-lb. P. & W. J57-P-13 (R)	39 8½	67 4½	N.A.	*28,000*	*40,000*	N.A.	M=1.85	40,000	14,000	52,000	N.A.	2,800	595	36,000	Ext. tanks
F3H-2N Demon	A.F.	Serv.	1	1×14,250-lb. Allison J71-A-2 (R)	35 4	58 11	519	22,130	33,900	65.3	730	S.L.	*12,000*	N.A.	N.A.	*1,500*	N.A.	N.A.	N.A.
F4H-1 Phantom II	A.F.	Dev.	2	2×16,000-lb. Gen. Elect. J79 (R)	38 5	56 0	N.A.	N.A.	40,000+	N.A.	M=2.2	40,000	N.A.	N.A.	N.A.	*1,500+*	N.A.	N.A.	N.A.
Martin																			
B-57B	B.	Serv.	2	2×7,200-lb. Wright J65-W-5	64 0	65 6	960	*30,000*	*49,500*	N.A.	*600*	35,000	N.A.	48,000	N.A.	2,300	N.A.	N.A.	N.A.
P5M-2 Marlin	M.R.	Serv.	7	2×3,400-h.p. Wright R-3350-32W	118 2½	101 9½	1,406.3	49,480	74,442	52.9	245	S.L.	N.A.	22,400	N.A.	2,050	N.A.	N.A.	2,339
North American																			
A3J-1 Vigilante	B.	Prod.	2	2×15,000-lb. Gen. Elect. J79-GE-2 (R)	50 0	70 0	N.A.	N.A.	*49,500*	N.A.	M=2+	40,000	N.A.	N.A.	N.A.	2,000	N.A.	N.A.	N.A.
F-100D Super Sabre	F.B.	Serv.	1	1×16,950-lb. P. & W. J57-P-21A (R)	39 9½	54 3	*400*	N.A.	29,760	N.A.	M=1.3	35,000	16,000	*50,000*	*4,500u*	1,150	N.A.	N.A.	1,450
FJ-4B Fury	F.B.	Serv.	1	1×7,700-lb. Wright J65-W-16A	39 1	37 6	N.A.	N.A.	26,000+	N.A.	715	S.L.	8,000	45,000+	N.A.	2,700	N.A.	N.A.	N.A.
T-28C	T.	Serv.	2	1×1,425-h.p. Wright R-1820-9HD	40 7½	32 9	268	N.A.	8,247	30.8	346	S.L.	3,830	37,000	1,140	1,060	250	10,000	104
T-39	G.P./T.	Prod.	2+4-8	2×3,300-lb. P. & W. J60-P-3	44 5	43 9	342.6	9,199	17,760	51.8	575	36,000	N.A.	N.A.	N.A.	1,725	500	10,000+	708
T2J-1 Buckeye	T.	Serv.	2	1×3,400-lb. Westinghouse J34-WE-36	36 0	38 4	255	N.A.	9,480	37.1	494	25,000	*5,000*	41,000	*2,010*	967	422	40,000	484
Northrop																			
F-99-4 Scorpion	A.F.	Serv.	2	2×8,000-lb. Allison J35-A-35 (R)	59 8	53 10	562	N.A.	46,000	81.8	630	S.L.	N.A.	51,000	N.A.	*1,200*	N.A.	N.A.	N.A.
N-155F Freedom Fighter	F.	Prod.	1	2×3,950-lb. Gen. Elect. J85-GE-5 (R)	25 5	43 11	170.0	N.A.	12,192	71.7	M=2+	35,000	N.A.	N.A.	N.A.	2,000+	N.A.	N.A.	*1,000*
T-38 Talon	T.	Prod.	2	2×3,850-lb. Gen. Elect. J85-GE-5 (R)	25 3	43 1	170	*7,000*	10,950	64.5	M=1.28	35,000	N.A.	*55,000*	N.A.	*1,200*	*590*	35,000	483
Republic																			
F-84F Thunderstreak	F.B.	Serv.	1	1×7,200-lb. Wright J65-W-3	33 7½	43 4½	N.A.	N.A.	26,000	N.A.	695	S.L.	8,200	49,000	N.A.	1,700	N.A.	N.A.	Ext. tanks
F-105D Thunderchief	F.B.	Prod.	1	1×25,500-lb. P. & W. J75-P-19W (R)	34 11	63 1	N.A.	N.A.	*40,000*	N.A.	M=2+	35,000	N.A.	*50,000*	N.A.	2,000+	N.A.	N.A.	Ext. tanks
Sikorsky																			
H-37A (and HR2S-1) Mojave	Tp. Hel.	Serv.	3+23	2×2,100-h.p. P. & W. R-2800-54	72 0*	82 10	4,070*	20,690	30,188	7.42*	130	S.L.	990	8,700	—	138	115	1,000	333
H-34A Choctaw (and HSS-1, HUS-1)	A.P. Hel.	Serv.	2+14	1×1,525-h.p. Wright R-1820-84	56 0*	46 9	2,460*	7,646	11,867	4.82*	134	S.L.	1,500	12,000	—	225	101	1,000	165
HSS-2	A.S.	Prod.	N.A.	2×1,050-h.p. Gen. Elect. T58-GE-6	62 0*	54 9	3,019*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Temco																			
TT-1 Pinto	T.	Serv.	2	1×920-lb. Continental J69-T-9	29 10	30 7	150	3,139	4,400	29.3	345	15,000	1,900	32,200	2,995	405	270	25,000	103
Vertol (Boeing)																			
HUP-2 Retriever (and H-25A)	A.P. Hel.	Serv.	2+4	1×550-h.p. Continental R-975-46	35 0*	32 0	2×950*	4,132	5,750	3.0*	105	S.L.	1,000	10,000+	—	340	80	1,000	N.A.
Model 44A	A.P. Hel	Serv.	2+20	1×1,425-h.p. Wright Cyclone 977C9 HD1	44 0*	52 6	2×1,520*	8,990	15,000	4.93	127	S.L.	1,050	N.A.	—	280	101	1,000	250
YHC-1B Chinook	A.P. Hel.	Dev.	2+40	2×2,300-h.p. Lycoming T55-L-5	57 0*	50 0	2×2,551*	N.A.	N.A.	N.A.	N.A.	N.A.	*2,500+*	N.A.	N.A.	*230*	*144*	5,000	N.A.
U.S.S.R.																			
Antonov																			
An-2 ("Colt")	G.P./T.	Serv.	2+14	1×1,000-h.p. ASh-62-IR	59 7½	42 0	770	7,275	11,575	15.0	161	S.L.	N.A.	16,400	N.A.	1,100	124	5,000	280
Ilyushin																			
Il-14 ("Crate")	T.	Serv.	3+28	2×1,900-h.p. ASh-82T	103 11	69 11	1,076	26,630	36,380	33.8	246	S.L.	1,045	23,000	N.A.	1,990	162	10,000	550
Il-28 ("Beagle")	B.	Serv.	4	2×5,955-lb. VK-1	*69 0*	*62 0*	N.A.	*26,000*	*39,000*	N.A.	580	S.L.	2,950	41,000	N.A.	1,600	450	35,000	2,620
Il-? ("Blowlamp")	B.	Serv. (?)	3	2×*18,040-lb. M-209* turbojets	*58 5*	*71 9*	N.A.	*34,000*	*65,000*	N.A.	*M=1.3*	36,000	N.A.	N.A.	N.A.	*1,490*	*610*	*36,000*	N.A.
Kamov																			
Ka-15 ("Hen")	G.P. Hel	Serv.	2	1×255-h.p. AI-14V	32 8½*	N.A.	840*	—	2,805	3.34	106	1,000	N.A.	9,840	—	195	78	1,000	N.A.
Mikoyan/Gurevich																			
MiG-15*bis* ("Fagot")	F.	Serv.	1	1×5,955-lb. VK-1	33 1½	35 4	255	8,320	11,095	43.5	685	S.L.	10,400	49,000+	N.A.	*2 hr.*	N.A.	N.A.	Ext. tanks
MiG-17 ("Fresco-C")	F.	Serv.	1	1×7,590-lb. VK-1A (R)	*36 0*	*39 0*	265	9,950	13,200	50.0	645	36,000	10,500	57,100	N.A.	1,160	N.A.	N.A.	539
MiG-19 ("Farmer")	F.	Serv.	1	2×8,818-lb. Type 37V (?)	36 6	43 3	N.A.	N.A.	19,940	N.A.	M=1.4	20,000	*15,000*	*58,000*	N.A.	600	N.A.	N.A.	N.A.
MiG-21 ("Faceplace")	F.	Serv. (?)	1	1×*18,000-lb.* turbojet (R)	*27 0*	*46 0*	*250*	*12,000*	*20,000+*	N.A.	M=1.5–2.0	30,000	*15,000*	*60,000*	N.A.	*350*	N.A.	N.A.	N.A.
Mil																			
Mi-1 ("Hare")	G.P. Hel.	Serv.	1+3	1×575-h.p. AI-26V	45 11*	39 8	1,650	3,925	4,960	3.01*	115	S.L.	1,280	N.A.	—	240	60	1,000	N.A.
Mi-4 ("Hound")	G.P. Hel.	Serv.	2+14	1×1,700-h.p. ASh-82V	68 11*	55 1	3,710*	N.A.	15,875	4.28*	130	5,000	N.A.	16,000	—	300	93	1,000	N.A.
Myasishchev																			
("Bison")	B.	Serv.	*8–10*	4×*19,180-lb.* AM-3M	*170 7*	*162 5*	*3,660*	N.A.	*352,750*	N.A.	*559*	40,000	N.A.	*40,000*	N.A.	*7,000*	*520*	35,000	N.A.
Sukhoi																			
("Fishbed")	F.	?	1	1×*11,000-lb.* turbojet	*25 0*	*49 0*	N.A.	N.A.	*18,750*	N.A.	*M=1.7*	36,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
("Fishpot")	F.	Serv. (?)	1	1×*19,840 Type 31*	*25 0*	*50 0*	*260*	N.A.	*25,000*	N.A.	*M=2.0+*	40,000	*15,000+*	*60,000+*	N.A.	400	N.A.	N.A.	N.A.
Tupolev																			
Tu-14 ("Bosun")	B.	Serv.	4	2×5,955-lb. VK-1	*70 0*	*65 0*	N.A.	N.A.	*55,000*	N.A.	*560*	10,000	N.A.	*48,000*	N.A.	*1,800*	N.A.	N.A.	N.A.
Tu-16 ("Badger")	B.	Serv.	6–7	2×*19,180-lb.* AM-3M	111 6	118 0	2,002	N.A.	*175,000*	N.A.	620	10,000	N.A.	40,000	N.A.	*4,250*	*480*	*40,000*	*10,000*
Tu-20 (?) ("Bear")	B.	Serv.	*8*	4×12,000-h.p. NK-012M	*177 2*	*155 0*	*2,800*	N.A.	*340,000*	N.A.	*560*	10,000	N.A.	*34,000*	N.A.	*9,000*	*500*	*30,000*	N.A.
Yakovlev																			
Yak-11 ("Moose")	T.	Serv.	2	1×730-h.p. ASh-21	30 10	27 10½	166	4,410	5,512	33.2	286	7,380	1,770	23,300	*1,640u*	795	205	5,600	79
Yak-12M ("Creek")	L.	Serv.	4	1×240-h.p. AI-14R	41 4	29 6	259.8	2,262	3,197	12.4	113	S.L.	805	13,650	N.A.	280	99	5,000	N.A.
Yak-18 ("Max")	T.	Serv.	2	1×160-h.p. M-11FR	33 9½	25 6	183	1,795	2,470	13.5	153	S.L.	N.A.	13,120	*950u*	620	133.5	5,000	28.5
Yak-24 ("Horse")	G.P. Hel.	Serv.	3+40	2×1,700-h.p. ASh-82V	68 11*	80 0	2×3,710*	N.A.	28,000	3.77*	158	S.L.	N.A.	18,000	N.A.	300	117	1,000	N.A.
Yak-25 ("Flashlight A")	A.F.	Serv.	2	2×8,818-lb. Type 37V (?)	*40 8*	*54 7½*	*320*	*17,000*	*27,000*	N.A.	683	10,000	N.A.	*50,000*	N.A.	1,600	N.A.	N.A.	N.A.
("Backfin")	B.	?	—	2×*20,000-lb.*+ turbojets	*78 0*	*102 0*	N.A.	*55,600*	*128,000*	N.A.	*M=1.5*	36,000	N.A.	*60,000+*	N.A.	*3,500*	N.A.	N.A.	N.A.

Abbreviations.—A.F., all-weather fighter; A.S., anti-submarine; B., bomber; E.W., early warning aircraft; Ex., experimental or research aircraft; F., fighter; F.B., fighter-bomber; F.R., fighter-reconnaissance; G.P., general purpose; Hel., helicopter; L., liaison; M.R., maritime reconnaissance; O., observation; Res., rescue; S., strike; T., trainer; Tan/Tp., tanker-transport; Tp., transport; *b*, balanced field length; Dev., under development; *n*, no reserves; Prod., in production, not yet in service; Serv., in service; (R), thrust quoted with re-heat; *u*, distance to unstick; * helicopter rotor diameter, disc area and disc loading respectively. **DATA IN ITALICS ARE ESTIMATED OR APPROXIMATE.**

Personal Flying

FIRST Tipsy Nipper to be sold to a private owner in the United Kingdom was that handed over at White Waltham Aerodrome, Berkshire, on Mar. 14, when Air Cdre. C. B. Wincott, C.B.E., of Fairey Aviation, Ltd., handed over the log book to Mr. Paul Bannister. The new owner, who is a member of Wolverhampton Aero Club, promptly took off for home.

His aircraft, registered as G-APYB, holds a Belgian Certificate of Airworthiness which has been validated by the British Air Registration Board. As most people know the Tipsy Nipper, built by Avions Fairey S.A. of Gosselies, Belgium, is a single-seater with a 45 h.p. Stark Stamo dual-ignition engine, developed from the famous Volkswagen car engine.

Even with the 17½% U.K. import duty added, the price ex Gosselies comes to £1,127.

A Popular Flying Association Group has decided to form itself round a Tipsy Nipper. This Group, the first to adopt the Nipper, will use Newtownards airfield in Northern Ireland. The chairman is Mr. N. F. G. Harrison, whose address is "Kincora House," 16 Kincora Avenue, Earlswood Road, Belfast 4.

Other good news from the P.F.A. is that the annual subscription for Groups has been reduced from £10 to £4 4s. a year.

• • •

One of the obstacles to the really widespread use of American personal aircraft in this country is that virtually none is cleared for a British public transport C. of A. This means that they cannot be used by flying clubs, or for charter or any other commercial flying except for executive operations. The same goes for their lavish radio and navigational equipment, which with few exceptions, is not type-approved by the A.R.B.

FIRST OFF.—Mr. Bannister smiles broadly as he takes over his Tipsy Nipper from Air Cdre. Wincott.

Obviously, the next step is to get the aircraft and equipment re-categorized for public transport, but this promises to be no simple matter. As the Americans have a separate category for executive types and light aircraft for commercial operations, their designs are not specifically formulated to any of the British public transport requirements. And as the market here is so small, compared with the U.S. domestic scene, it seems that the manufacturing companies are not particularly interested in digging out all the basic design data for the A.R.B. to start its investigations for commercial operations approval.

Less complex solutions may present themselves but as things stand at the moment, the cost, not to mention the complication, of getting a public transport C. of A. for the American types is likely to be substantial.

Gliding Notes

by Dr. A. E. Slater

SOME confusion has arisen over the number of entries in the World Championships allowed to each nation. Britain and several other countries are entering three sailplanes each, as this, they were told, is the maximum number allowed. But in the Swiss *Aero Revue* for March, the leader of the Swiss team, Karl Ruckstuhl, announces that the number has again been raised to four, and gives a list of the Swiss entry: René Comte with an Elfe M and Bernhard Müller with a Weihe in the Open Class, and Kurt Baumgartner with a Mucha Standart and Alexandre Gründisch with a Fauvette in the Standard Class.

However, the B.G.A. has telegraphed the German Aero Club, which has replied confirming that only three entries per country are allowed. There have been far more Standard than Open entries. In *Sailplane & Gliding* Tony Goodhart has put out a suggestion which was first mooted in "Gliding Notes"—that contests be confined to the Open and Standard class alternately.

• • •

LEARNING to glide by means of aeroplane-towed launches alone was a method which came in for much discussion at the Instructors' Conference following the general meeting of the British Gliding Association. Paul Minton described how his club, being forced to do it for lack of other launching facilities, had been won over to aero-towing.

They found it costs only 2s. more to aero-tow an Eagle to 1,500 ft. than to launch a T-21 by winch to the same height. The Eagle, with its higher performance, gives better value for money by making a longer flight down; and it was rather surprising to hear that pupils have made perfect landings in the Eagle on only their second attempt, because it is so stable on the approach.

However, it is not the perfect machine for training, in Minton's opinion; he prefers side-by-side seating, so as to be able to diagnose the pupil's state of mind from his face; without this useful facility, it takes "quite a lot longer" to teach a pupil. Also the Eagle, being designed for fast flying, is somewhat heavy to launch; a lighter machine would be better for teaching beginners.

One disadvantage of aero-towed training, however, is that you cannot leave the pupil alone to correct his mistakes while on aero-tow, because, if he does not fly straight, the difficulties increase as the 5th power of the deviation of the glider from its correct position behind the aeroplane.

The conference also heard about a South African gliding club which had deliberately gone over to aero-towing for all flights, instructional and otherwise. What pleased them was the lack of delays due to "fumble," because the "driver" is so near to the glider which he is about to pull. But the club's pupils seem to need a lot of flying time, because they are given 30 tows, adding up to 10 hours, before being sent solo.

The French, said Ann Welch, have also used aero-towed training, and have given pupils 9 to 15 hours dual before sending them solo. The result, she said, is that "they don't suffer from bored pilots." They also keep to a strict timetable.

As to comparative expense, Ken Machin estimated that it costs £10 worth of winch-launching to reach the solo stage, but £35 worth of aero-tows. Against this is the reduced accident rate with aero-towing, and the reduced time, and therefore cost, in progressing from first solo to Silver "C."

• • •

AS is usual at these Instructors' Conferences, the accident statistics of the previous year were explained by Air Cdre. G. J. C. Paul. He reported a welcome reduction in the "stretch, stall and spin" category, which cost only £690 in repairs last year, compared with £2,906 in 1958 and £4,775 in 1957. But of the four classes into which he divides pilots, those with more than five hours' solo flying who have not yet qualified for the Silver "C," are still the most potentially dangerous.

• • •

WITH the wind blowing this way and that over Leeming aerodrome on Feb. 21, and violent gusts higher up, the R.A.F. gliding club there came to the conclusion that a "rotor" beneath a standing wave was sitting over the field, especially as the gusts tended to be upwards at the upwind end of the circuit but downwards on the landing approach. So the chief instructor, Flt. Lt. P. D. Lane, decided that the way to catch the wave was to push out farther upwind after release, regardless of gusts.

He therefore took an auto-tow to 1,100 ft. in the Sedbergh (T-21) and continued for a quarter of a mile at 42 kt. till he contacted perfectly smooth lift at 250 ft./min. up to 5,000 ft. He then explored the length of the wave, which lay parallel to the line of the Pennine Chain to the west, the evident source of the wave.

The lift area was three miles long across the wind, and while travelling along it the Sedbergh rose to 8,000 ft. and then more slowly to 9,300 ft., which appeared to be its ceiling. By this time Flt. Lt. Lane and his passenger, L.A.C. Hitchman, were pretty well frozen, so they moved downwind into the downdraught and at 2,500 ft. dropped into the rotor and its turbulence, which became especially violent from 1,500 ft. down to the ground.

After plotting the ups and downs and the rotor on a map, Flt. Lt. Lane concluded that he had caught the second lee wave 10 miles downwind of the 1,000-ft. contour of the Pennines; and that the wave-length was about six miles.

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The STOL Caribou transports 3 tons of cargo .... 2 jeeps .... up to 30 passengers .... or any combination of passengers and cargo.

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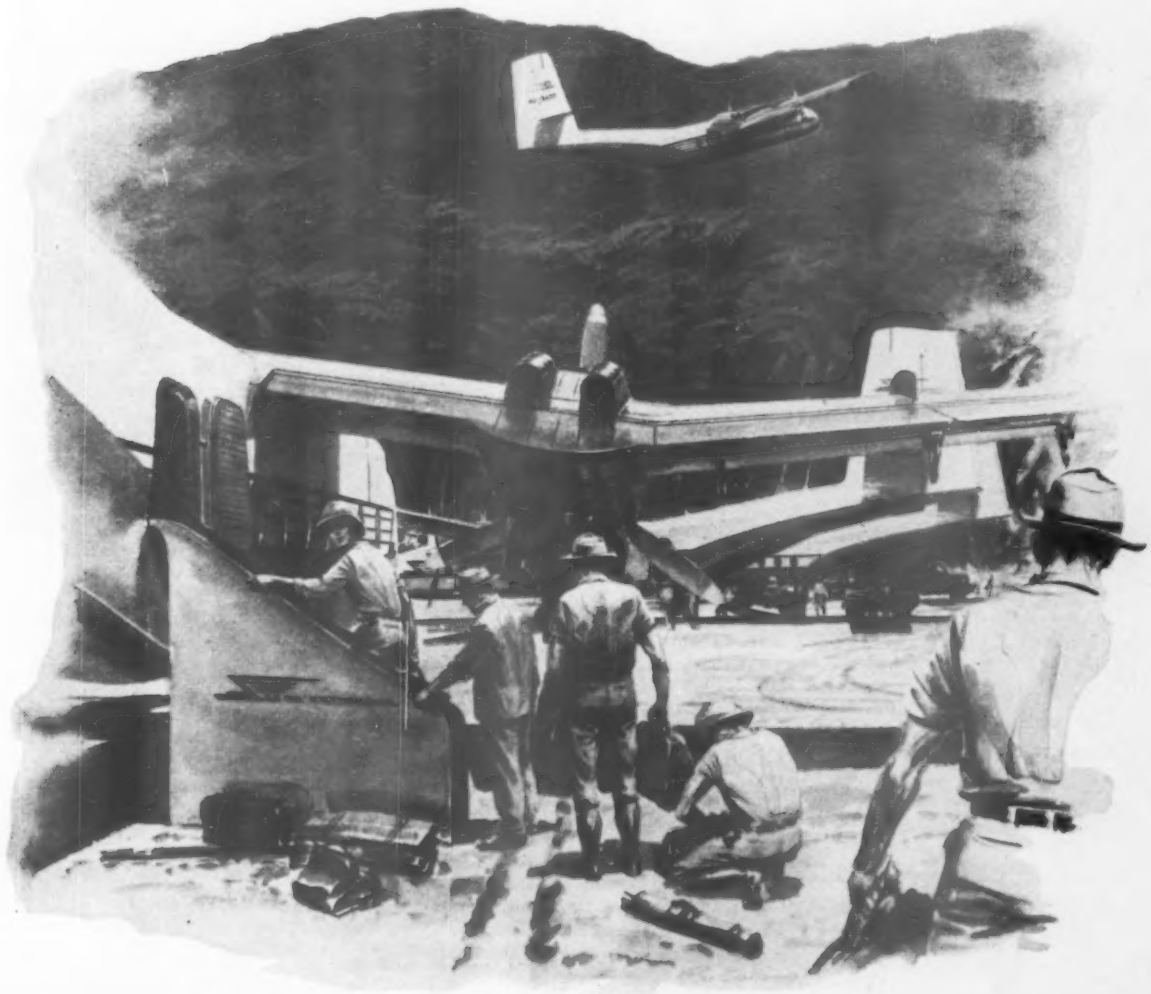
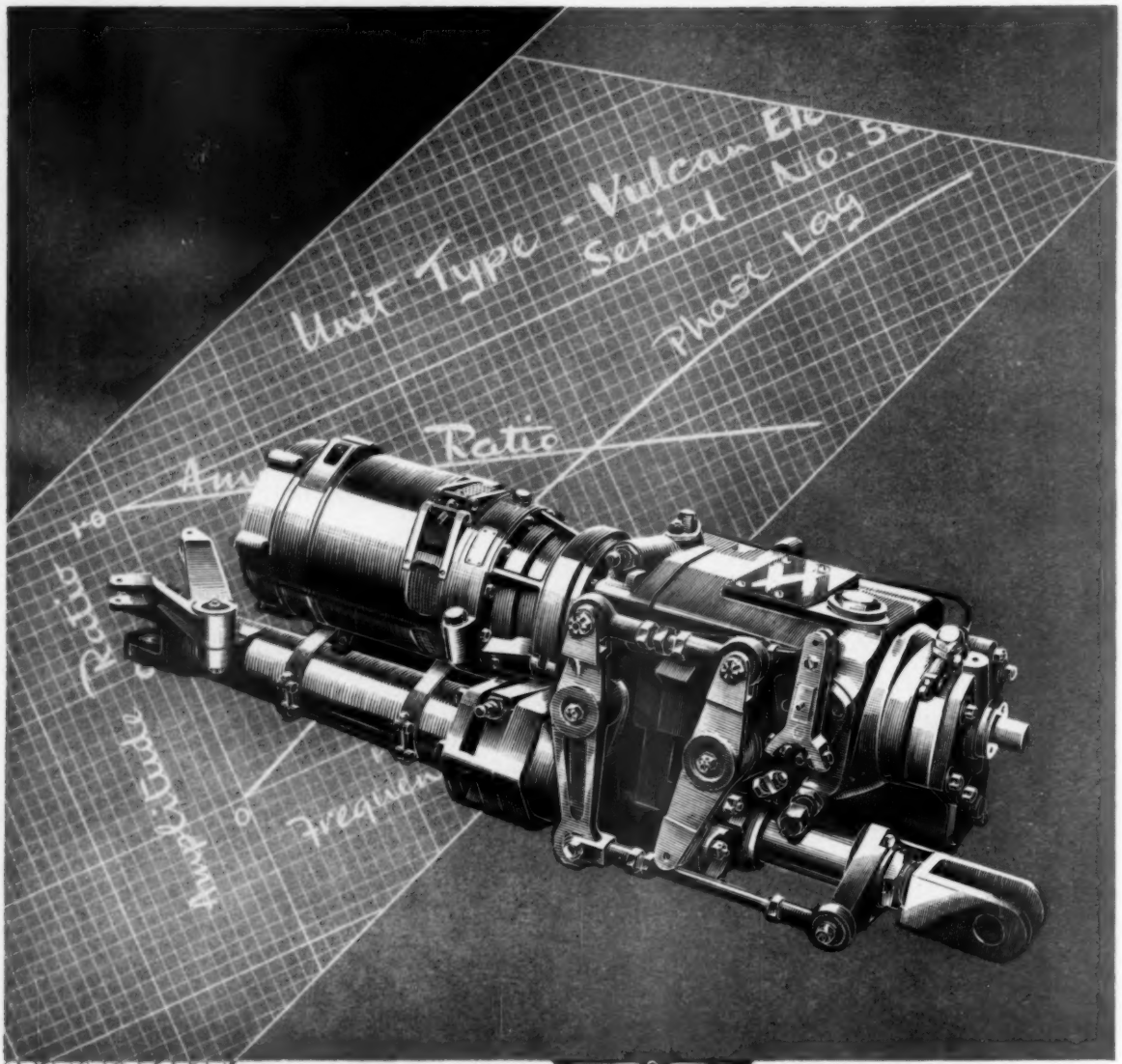
The STOL Caribou is a totally new concept in transport aircraft design.



DE HAVILLAND AIRCRAFT OF CANADA



POWER CONTROLS

The "packaged" powered flying control illustrated operates the outboard elevons of the Avro Vulcan B. Mk. 2 aircraft. The extreme compactness of this self-contained unit is achieved by the embodiment of a swash-plate main pumping element, while pressurisation of the fluid in the unit sump prevents fluid starvation and ensures efficient operation at high altitudes.

P.C.25

BOULTON PAUL AIRCRAFT LTD.
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Correspondence

Would the Princess Boats Cost too Much?

NOW that Air Vice-Marshal Bennett has given up the idea of buying the Princess boats (your leading article of Mar. 11) there could be no commercial objection to publication of an approximate breakdown of the costs and revenue likely to be involved. Such a breakdown would go a long way towards removing doubts about the feasibility of the Bennett scheme—which many of those in the air transport business consider to be impracticable.

Taking just one point: the Princess has done, I believe, only about 80 hours of flying. What would be the cost of the remainder of the test programme and of the necessary period (200 hours?) of proving after Tynes have been installed—with all that this would involve in the way of structural and systems redesign?

London, S.W.3. A. H. HENDERSON.

How Boats Copied Aeroplanes

YOUR issue of Feb. 12 describes the cold-moulded plywood fuselage of the new Halcyon, now building in a boat yard.

In 1912 and 1913 the Deperdussin firm were pioneering this kind of construction with such success that in 1913 a 160 h.p. Gnome-engined monoplane of this make became the first vehicle to cover 200 km. (124 miles) in the hour, and this round a small closed circuit!

Its plywood fuselage, designed by Bechereau, was built up in halves over a mould and subsequently joined longitudinally to give the first "monocoque" fuselage, without interior framing and with a most excellently "clean" exterior. Years later, after the last War, the boatbuilders took up the idea.

So now the wheel has gone full circle!

Ipswich. H. J. PARHAM.

A Modest Author

IN Norman Macmillan's splendid new book "Great Aircraft," he expresses disbelief at the end of the section devoted to the Spitfire that there is no V.C. in its history. Is it a fact that no one won his V.C. in one?

He gives credit to all pilots most closely identified in the aircraft about which he writes, with two exceptions, the Pixie and Fox. He is too modest to recall that the pilot in question was Norman Macmillan!

London, W.1. GEOFFREY DORMAN.

Efficiency in Administration

IN his letter published on Mar. 4, your correspondent R. H. Ayers attempts to support his contention that private enterprise is more efficient than State enterprise, rather less convincingly than he ought, for it is a far-reaching contention with serious implications.

The arguments your correspondent brings to bear suggest that his acceptance of the contention is a matter of faith rather than intellectual conviction. For instance, is it not specious reasoning to use the result of a General Election as evidence of the truth of a principle and since when has it been possible to determine economic laws by popular ballot?

Secondly, Mr. Ayers' definitions leave much to be desired. If, as he says, he implies the State Corporations are efficient but the Independents are more efficient, then either he must accept that the former are inefficient in relation to the latter or else he must define the basic efficiency index against which he is measuring both.

Thirdly, Mr. Ayers is unreasonable in refusing to accept that, in having to raise capital at fixed rates of interest, the Corporations bear a continual high charge against revenue and occupy therefore a less favoured position than the Independents who have access to equity capital which receives only a share of profits. Furthermore, the inflow of capital into the Independents has not come generally from the open market, but out of the profits of another form of transport and this inflow has not been attracted by current high profits but clearly represents a prudent investment against expected future competition. Moreover, profits and profitability are different concepts.

It is B.E.A.'s declared policy "to pursue an expansionist policy and recognize that this policy involves greater financial risks than might be incurred in a more continuous development." It is necessary therefore to measure B.E.A.'s rate of expansion in concert with the level of the profits. By contrast, private enterprise, if it is to look after its shareholders, will only expand in order to earn greater profits. In relation to many other European operators B.E.A.'s expansion is impressive. I do not know how one might determine whether in private hands the airline would have been more efficient, or whether it would have expanded more or less than B.E.A. Without a great deal more information it is unwise to speculate.

Mr. Ayers is also vague. He says that he believes that it takes more ground personnel to operate a State airline than an Independent in proportion to the "operations achieved." He says that this is his yardstick, but what on earth is it? Passenger miles, capacity ton-miles, revenue miles flown, number of services operated, number of passengers carried, number of aeroplanes, or what? Does he take account of distance, frequency, and agency agreements, to mention but a few of the factors which affect staff numbers?

Finally, has Mr. Ayers been able to draw comparison between all the State airlines and all the private airlines which is what he ought to do in order to make his case? Does he really believe that no State enterprise is more efficiently operated than a comparable private one and if so, might one prise from him a clear definition of "efficiency" so that we may all judge?

Cheam, Surrey. DAVID HOLLINGS.

Groundabout

Have Column—Will Travel

Aboard H.M.S. "Ark Royal":

To the air-conditioned passenger like you and me, shipboard travel can be slightly fraught. For instance, as the Ark was taxi-ing—er, manœuvring—out of Devonport, all engine sound suddenly stopped. The only Wren on board found the silence deafening. Then, at sea, the ship judders a little on the turn, akin to some aircraft when approaching the barrier. What is the nautical equivalent of Mach 1? I hear that the latest nuclear submarines are on the fringes of it.

Cdr. (Air) Dickie Reynolds had mixed feelings about the strong west wind—the seaman in him knew that it might prevent the Ark from leaving port but it was just what he wanted to help his Sea Vixens, Scimitars and Gannets to land on. All, in the end, went smoothly.

When a Scimitar pilot, flying from Lossiemouth, said the weather at 37,000 over Yeovilton was "loud and clear" an officer in the Ark, which was in temporary murk off Lyme Bay, mildly suggested "Let's take the ship *there*."

Always quick to learn, I discovered that a Davy miner's lamp is standard issue to Sea Vixen and Gannet observers; that an Avon has about two buckets-full of blades (Authority: Engnr. Officer who once saw an Avon ingest a metal casting); and that the Scimitar pilots have reached that pitch of airmanship (and I have their word for it) where they ask "Flyco" which arrester wire he wants hooked.

*

Ward-Room Wisdom

"I don't know what these civil flying control people are worrying about—Scimitars only use *vertical* air."

"He's the sort of chap you could take anywhere, once."

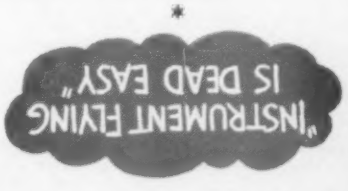
"The Work Study people have been so efficient that they didn't leave any room for *themselves* on the ship."

"He's a bit vague but he's got a useful smile."

"With these big new aircraft, you can only move about the hangar if you take the buttons off your jacket and shuffle sideways."

"I'm told that when an R.A.F. pilot first saw the Gannet all folded for striking down, he asked if anyone had been hurt in the crash."

*



by Wren

Industry Record

Simulator Contract

Aer Lingus, who are to take delivery of the first of three Boeing 707-048s in November, have signed a contract with General Precision Systems, Ltd., of Aylesbury, for a flight simulator to be used for pilot training and instrument rating renewals.

The simulator, which is scheduled for installation in Dublin by the end of the year, will cost about £100,000. It is the first simulator ever to be purchased by Aer Lingus and is designed for the training of crews throughout the full range of operation of the Boeing 707-048. Two engineers from Aer Lingus will be trained at the simulator school at Aylesbury by G.P.S., who will also assist the airline with the installation of the simulator in Dublin.

Airtech Ltd., has received an M.o.A. contract for an air transportable transmitting and receiving station/message centre. The station utilizes a number of Airtech Aircon containers (right) which have recently been approved following a series of Service trials.

Careers and Training

Wilmot Breeden, Ltd., of Birmingham, have produced a brochure of their apprentice training schemes which cover the craft, engineering, scientific and commercial fields. The company's contribution to the aircraft industry covers the precision fabrication of light-alloy components, the manufacture of complete accessories for jet engines, and the development of new production techniques.

Magnesium-Alloy Forging

Technical data on Magnuminium and magnesium-zirconium wrought alloys are included in a new booklet published by High Duty Alloys, Ltd., of Slough. Entitled "Forging in Magnesium Alloys," the publication deals with three Magnuminium alloys—Magnuminium 133, Magnuminium 133X and Magnuminium 266—and the magnesium-zinc-zirconium alloy ZW3 manufactured under licence from Magnesium Elektron, Ltd. These data sheets enable an appropriate alloy for particular requirements to be chosen; if required, however, more detailed information is available on request from the company.

Draft British Standards are at present in course of preparation covering Magnuminium 266 and ZW3 alloy. But where possible, the physical and specified mechanical properties given in these draft specifications are included in the booklet.

Turbine Starter

A new range of lightweight turbine engine starter systems for use with military and commercial jet aircraft has been developed by Hamilton Standard, a division of the United Aircraft Corporation. The starter has been under development for the past year and is called the Hi-Lo system. It couples a conventional low-pressure pneumatic starter with a high-pressure valve.

The system is designed to operate from standard high- or low-pressure ground units available at any airfield; from ground or airborne high-pressure bottles; or from air cross-bled from other engines of multi-engined aircraft.

R.R.E. Airfield Control

The Ministry of Aviation, acting on behalf of the Royal Radar Establishment at Malvern, has placed an order with the Marconi company for the supply and installation of a 50-kW. 50-cm. airfield control radar Type S264, together with two moving-coil display units and ancillaries. The equipment, which will be sited at the R.R.E. airfield at Pershore, Worcestershire, is scheduled to go into operation in mid-1960.

Several years ago one of the earliest 50-cm. radars, a Type 11, was installed at Defford. It was later transferred with the Establishment to Pershore and has been in constant use ever since.

Tyre Maintenance and Repair

The Technical Service (Aircraft) Division of the Firestone Tyre and Rubber Co., Ltd., has published a new book on aircraft tyre and tube maintenance and repair. One section of this manual deals with the subject of tread wear and the recommended point of wear for each of the different Firestone tread patterns at which tyres should be removed from service.

Aviation Calendar

March 29

London Airport Central.—Institute of Transport West Middlesex Group lecture, "Rotary Wing Aircraft," by Sqn. Ldr. W. R. Gellatly, in the Conference Room, 3rd floor Control Tower Building, at 18.30 hrs.

Salford.—Royal Technical College lecture, "Man in Space," by Sqn. Ldr. J. Ernsting, at the Royal Technical College, at 19.00 hrs.

March 30

Hatfield.—R.Ae.S. Hatfield Branch lecture, "Ballistic Vehicles," by G. K. C. Pardoe, in the de Havilland Restaurant, at 18.15 hrs.

Hull.—R.Ae.S. Brough Branch lecture, "Artifical Satellites," by Dr. L. R. Shepherd, at the Royal Station Hotel, at 19.30 hrs.

Preston.—R.Ae.S. Preston Branch lecture, "The Salvage of the 'Empress of Canada'," by Capt. C. R. Colbeck, in the R.A.F.A. Hall, at 19.30 hrs.

Southampton.—R.Ae.S. Southampton Branch A.G.M. and talk by P. Norman, in the Engineering Lecture Theatre, University of Southampton, at 20.00 hrs.

March 31

Yeovil.—R.Ae.S. Yeovil Branch lecture, "Refrigeration," by Dr. E. W. Still, at Park School, Park Road, at 19.30 hrs.

April 4

Amesbury.—R.Ae.S. Boscombe Down Film Programme, in the Lecture Hall, A. and A.E.E., at 17.30 hrs.

Cambridge.—R.Ae.S. Branch lecture by Wg. Cdr. R. P. Beamont, in No. 1 Lecture Hall, Cambridge University Engineering Laboratories, at 20.15 hrs.

Derby.—R.Ae.S. Branch lecture, "The Vickers Vanguard," by G. F. H. Hemsley, in the Rolls-Royce Welfare Hall, Nightingale Road, at 18.15 hrs.

4-8. Milan.—4th NATO AGARD Combustion and Propulsion Colloquium discussion on "High Mach Number Air-breathing Engines."

Company Notices

Thames Alum, Ltd. (649,648).—Private co. Reg. February 16. Cap. £30,000 in £1 shs. Objects: To carry on the business of manufacturers of and dealers in aluminium sulphate, alumina, aluminium compounds and alloys, ferrous and non-ferrous metals and chemicals and chemical substances. Subscribers (each with one share): Alumina Co., Ltd., Iron Bridge Chemical Works, Widnes, Lancs.; Aluminium Sulphate, Ltd., 9 Basinghall Street, E.C.2.; Peter Spence and Sons, Ltd., 15 Norfolk Street, Manchester, 2. Sols.: Slaughter and May, 18 Austin Friars, E.C.2.

Mac. Smith Air Charter, Ltd. (649,888).—Private co. Reg. February 18. Cap. £5,000 in £1 shs. Objects: To carry on the business of operators and charterers of aircraft, etc. Directors: Malcolm Smith, Tudor Cottage, The Drive, Gosforth, Newcastle upon Tyne; Donald Ireland, High Ways, Edge Hill, Darras Hall, Ponteland, Newcastle upon Tyne. Sec.: Kenneth Patterson. Sols.: Holmes and McGilbray, Newcastle upon Tyne. Reg. off.: Mill House, Claremont Street, Newcastle upon Tyne, 2.

British Aircraft Corporation, Ltd. (650,233).—Private co. Reg. February 23. Cap. £100 in £1 shs. Objects: To design, manufacture, import, export and deal in aeroplanes, airships, seaplanes, aircraft, guided missiles, rockets, etc. Subscribers (each with one share): Marion Simmons and Gwendoline G. Elliston, both of 59-67 Gresham Street, E.C.2. First directors are not named. Sols.: Linklaters and Paines, 59-67 Gresham Street, E.C.2.

Vickers-Armstrongs (South Marston), Ltd. (650,298).—Private co. Reg. February 23. Cap. £100 in £1 shs. Objects: To carry on the business of general engineers, aircraft and mechanical engineers, electrical and electronic engineers, etc. Other particulars are similar to those for British Aircraft Corporation, Ltd.

Vickers-Armstrongs Aircraft (1960).—Private co. Reg. February 23. Cap. £100 in £1 shs. (650,323). Other particulars are similar to those for British Aircraft Corporation, Ltd.

New Patents

APPLICATION ACCEPTED

833,895.—Krautkrämer, A.—"Toy helicopter adapted to be shot into the air by extraneous means of projection."—Oct. 4, 1957. (Mar. 5, 1957.)

Printed specification of the above will be available on May 4, 1960, and the opposition period will expire on Aug. 4, 1960.

Personal Notices

BIRTHS

Cozens.—On March 12, at Princess Beatrice Hospital, S.W.5, to Gillian (*née* Piggott), wife of Air Cdre. H. I. Cozens—a son.

Davies.—On March 13, at Maidenhead, to Gillian (*née* Way), wife of Sqn. Ldr. H. J. Davies—a daughter.

Smith.—On March 10, in Berlin, to July (*née* Ratcliff), wife of Flt. Lt. F. J. Smith—a son.

DEATHS

Bowhill.—On March 12, Air Chief Marshal Sir Frederick William Bowhill, G.B.E., K.C.B., C.M.G., D.S.O.

Cartwright.—On March 2, Dr. John Fraser Cartwright, works medical officer, Sir W. G. Armstrong Whitworth, Ltd., Coventry.

Templeton.—On March 10, Capt. David Alan Templeton, D.F.M., of Scottish Aviation (Flt. Lt., R.A.F., retd.).

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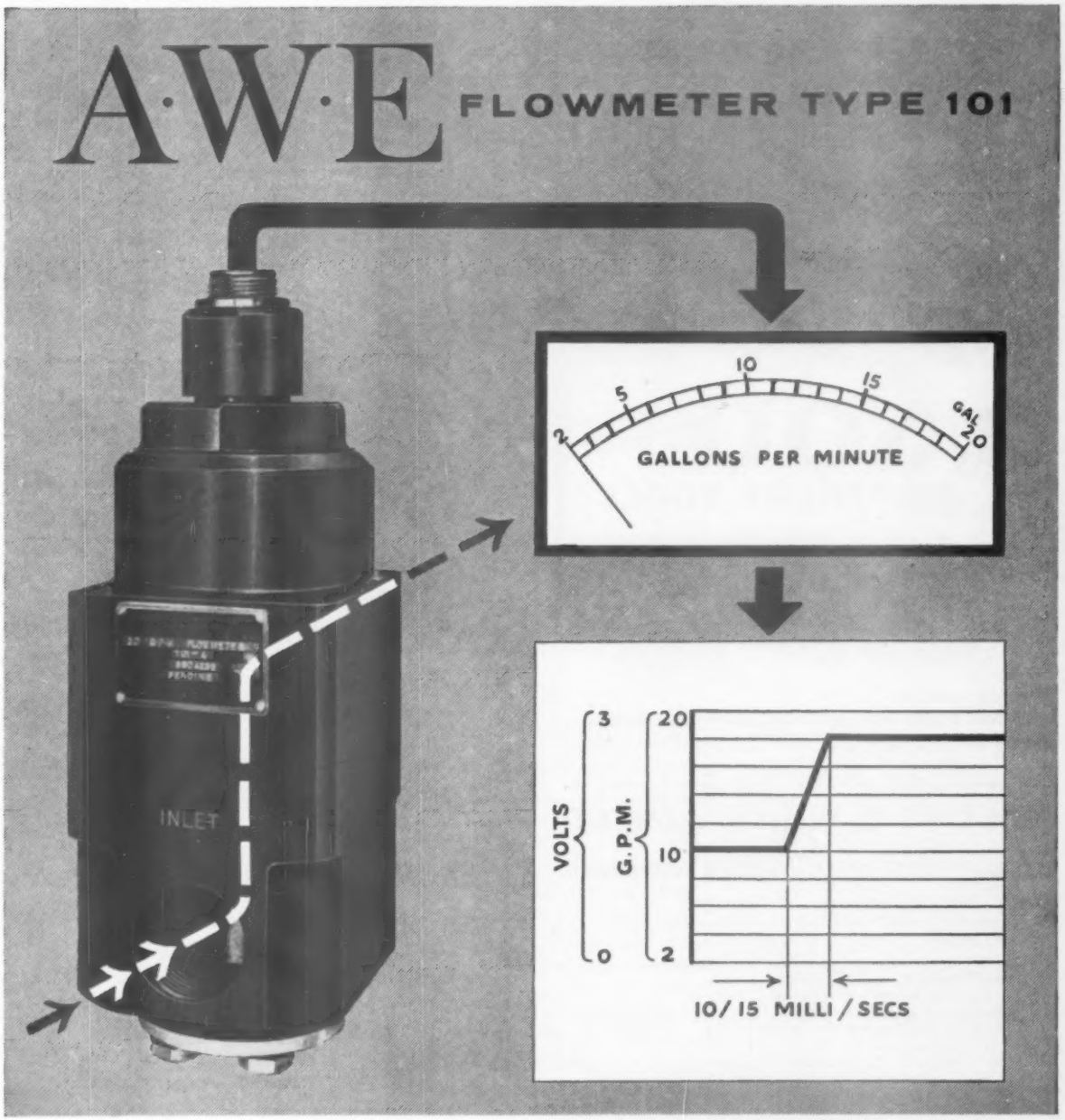

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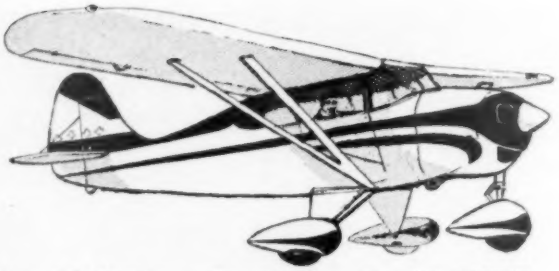

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NOTICES

AIR TRANSPORT ADVISORY COUNCIL.

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:—

FROM EAGLE AIRWAYS, LTD., OF 40 EDGWARE ROAD, LONDON, W.2:—

APPLICATION NO. 1042/6 for permission to include an optional traffic stop at Luxembourg on the following Normal Scheduled Services:—

Glasgow (opt.)-London-Lyons (opt. tech.)-Pisa (Application No. 1042).

Glasgow (opt.)-London-Lyons (opt. tech.)-Rimini or Forli (Application No. 1717).

FROM SILVER CITY AIRWAYS, LTD., OF 62 BROMPTON ROAD, LONDON, S.W.3:—

APPLICATION NO. 3310 (amended) for a Normal Scheduled Service with Hermes, DC6, DC6B and Viscount aircraft for the carriage of passengers, supplementary freight and mail on the route Manston (opt.)-Lydd (opt.)-Bournemouth (Hurn) (opt.)-London (Gatwick) (opt.)-Lisbon-Porto Santo, at a frequency of two return flights weekly with an additional two return flights weekly on the Lisbon-Porto Santo sector, for seven years from the opening date of Porto Santo Airport.

FROM CAMBRIAN AIRWAYS, LTD., OF CARDIFF (RHOOSE) AIRPORT, NR. BARRY, GLAMORGAN:—

APPLICATION NO. 968 (amended) for a Normal Scheduled Service with Heron, DC3 and Viscount aircraft for the carriage of passengers, supplementary freight and mail on the route London and/or Cardiff and/or Bristol-Cork, at a frequency in accordance with traffic demand for 10 years from date of approval.

APPLICATION NO. 969 (amended) for a Normal Scheduled Service with Heron, DC-3 and Viscount aircraft for the carriage of passengers, supplementary freight and mail between Swansea and Cork, at a frequency in accordance with traffic demand for 10 years from date of approval.

FROM STARWAYS, LTD., OF LIVERPOOL AIRPORT, LIVERPOOL 24:—

APPLICATION NO. 3428 for a Vehicle Ferry Service with Bristol 170 aircraft, for the carriage of vehicles, freight and incidental passengers, between Valley and Dublin at an initial frequency of four return flights daily increasing later in accordance with traffic demand for seven years from May, 1960.

These applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on July 30, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. 527-11

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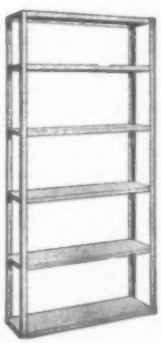

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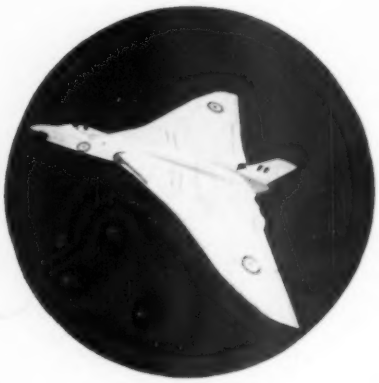

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